UNIVERSITY OF VERMONT

AND STATE AGRICULTURAL COLLEGE

TWELFTH

ANNUAL REPORT

OF THE

VERMONT AGRICULTURAL

EXPERIMENT STATION

BURLINGTON, VT.

1898-99.

BURLINGTON:
FREE PRESS ASSOCIATION,
1899.

THE VERMONT

Agricultural Experiment Station

BURLINGTON, VT.

BOARD OF CONTROL

PRES. M. H. BUCKHAM, *ex-officio*, Burlington.

HON. E. J. ORMSBEE, Brandon.

HON. CASSIUS PECK, Burlington.

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OFFICERS OF THE STATION

J. L. HILLS, Director.
G. H. PERKINS, Entomologist.
L. R. JONES, Botanist.
F. A. WAUGH, Horticulturist.
F. A. RICH, Veterinarian.
CASSIUS PECK, Farm Superintendent.
C. H. JONES, Chemist.
B. O. WHITE, Assistant Chemist
G. W. STRONG, Dairyman.
MARY A. BENSON, Stenographer.
E. H. POWELL, Treasurer.

ANNOUNCEMENT

The Vermont State Agricultural Experiment Station was established in accordance with an act of the General Assembly, approved November 24, 1886, for the purpose of promoting agriculture by scientific investigation and experiment. The station was established in connection with the University of Vermont and State Agricultural College, and for the past eleven years has received the funds appropriated by congress under the provisions of the act commonly known as the "Hatch Act," approved March 2, 1887. The state appropriation expired in 1890. An appropriation "not to exceed $1000 annually" was made by the last legislature for the purpose of printing the annual report.

The station is prepared to analyze and test fertilizers, cattle foods, seeds, milk, and other agricultural materials and products—exclusive of water—to identify grasses, weeds, blights, etc., and insects, and to give information on various subjects of agricultural science for the use and advantage of the citizens of Vermont.

All chemical analyses, etc., proper to an experiment station, that can be used for the public benefit, will be made without charge, so far as time and means permit. The station will undertake no work the results of which are not at its disposal to use or publish if deemed advisable for the public good. The results of each analysis will be promptly communicated to the party sending the sample. Those that are of general interest will be published in the annual report or in bulletins for free distribution. The work of the year will be summed up in the annual report of the station.

It is the wish of the Board of Control to make the station as widely useful as its resources will admit. Every Vermont citizen who is concerned in agriculture, whether farmer, manufacturer or dealer, has the right to apply to the station for any assistance that comes within its province to render, and the station will respond so far as it lies in its power. All communications, relating to agriculture, horticulture, plant or animal diseases, insects, etc., will be fairly considered, and, so far as possible, promptly answered.

The station farm and buildings are on the Williston road, adjoining the university grounds on the east. Electric cars pass within a quarter of a mile of the station building, at Colchester Avenue and University Place. Both the station and the farm have telephone connections and may be spoken from most telephone offices in the state.

Instructions for taking samples of fertilizers, fodders, milk, etc., will be sent on application. Parties desiring to send samples should first write for these directions. Many samples received are useless, being incorrectly drawn. Parcels by express, to receive attention, should be prepaid and should bear the address of the shipper for purposes of identification.

Copies of the reports and bulletins of the station are sent free of charge to any address upon application.

Address all communications, not to individual officers, but to the

EXPERIMENT STATION, BURLINGTON, VT.

TABLE OF CONTENTS

OF BULLETINS 66-71, PAGES 1-16, 1-116, PUBLISHED DURING THE YEAR BUT NOT INCLUDED IN THIS VOLUME

TABLE OF CONTENTS

OF TWELFTH ANNUAL REPORT

FINANCIAL REPORT FOR THE FISCAL YEAR ENDING JUNE 30, 1899

Vermont Agricultural Experiment Station, in account with the United States Appropriation, 1898–99.

DR.

To receipts from the Treasurer of the United States as per appropriation for fiscal year ending June 30, 1899 as per act of Congress approved March 2, 1887.....$15,000.00

CR.

	Abstract.	
By Salaries	1	$8,119.50
" Labor	2	2,076.24
" Publications	3	1,874.25
" Postage, stationary and telegrams	4	419.94
" Freight and express	5	82.74
" Heat, light and water	6	210.86
" Chemical supplies	7	242.47
" Seeds, plants and sundry supplies	8	126.76
" Fertilizers	9	6.00
" Feeding stuffs	10	880.85
" Library	11	26.07
" Tools, implements and machinery	12	36.19
" Furniture and fixtures	13	.....
" Scientific apparatus	14	129.69
" Live stock	15	.....
" Travelling expenses	16	721.96
" Contingent expenses	17	6.33
" Building and repairs	18	40.15
		$15,000.00

We, the undersigned, duly appointed auditors of the corporation, do hereby certify that we have examined the books and accounts of the Vermont Agricultural Experiment Station for the fiscal year ending June 30, 1899, that we have found the same well kept and classified as above, and that the receipts for the year from the treasurer of the United States are shown to have been $15,000, and the corresponding disbursements $15,000, for all of which proper vouchers are on file and have been by us examined and found correct.

And we further certify that the expenditures have been solely for the purposes set forth in the act of Congress approved March 2, 1887.

Signed,

{ SEAL. }

MATTHEW H. BUCKHAM,
CASSIUS PECK,
GARDNER S. FASSETT,
} Auditors.

ATTEST, E. HENRY POWELL,
Custodian.

Receipts and disbursements under sections 4346–4359, Vermont statutes, (fertilizer law); No. 83 of the acts of 1898 (feeding-stuffs law); No. 81 of the acts of 1898 (creamery inspection law); for the fiscal year ending June 30, 1899.

DR.

A.	To amount due Sept. 1 from state treasurer (license fees for 1899, commercial fertilizers)		$1,800.00
B.	To funds received from sale of inspection tags for feeding stuffs and forwarded to state treasurer		293.20
C.	To receipts from applicants for licenses	$226.00	
	" " " supply houses, creameries and cheese factories for testing Babcock glassware	441.43	
		$667.43	
	To overdraft	3.41	
			$ 670.84

CR.

	A	B	C
By Salaries	$553.65	$100.00	$274.00
" Labor	120.49	9.04	131.91
" Publications	385.15	.....	.....
" Postage, stationery, and telegrams	28.27	90.32	41.08
" Freight and express	14.44	0.68	5.88
" Heat, light and water	60.37	.....	9.25
" Chemical supplies	233.12	22.50	47.75
" Milk, cream and sundry supplies	.....	.....	45.10
" Tools, implements and machinery	.....	.....	80.11
" Furniture and fixtures	.....	.....	2.02
" Travelling and sampling expenses	404.49	.....	.....
" Contingent expenses	.....	[1]25.41	[2]33.74
Add amount forwarded to state treasurer against which no expenditures had been incurred prior to July 1, 1899		45.25	
	$1,800.00	$293.20	$670.8

1 Inspection tax tags. 2. Includes $26.00 returned to applicants to whom licenses were refused.

REPORT OF THE DIRECTOR

J. L. Hills

The present report covers the work of the station during the past fiscal year, July 1, 1898, to June 30, 1899. The bulletins and report are both indexed in the latter.

PUBLICATIONS

Six bulletins and the 11th annual report, aggregating over 360 pages of printed matter, have been issued during the year in editions of 8500 to 10,000 and distributed to the entire mailing list. One poster bulletin concerning apple canker and bi-weekly newspaper bulletins beginning in the spring have been published. Abstracts of the regular bulletins appear on pages 133–136.

1898, September, No. 66. Club root and black rot, 16 pages.
December, No. 67. Hybrid plums, 30 pages.
December, Eleventh annual report, 284 pages.
1899, January, No. 68. Inspections of milk tests and feeding stuffs, 8 pages.
March, No. 69. Analyses of commercial fertilizers, 16 pages.
April, No. 70. Analyses of commercial fertilizers, 16 pages.
May, No. 71. Analyses of commercial fertilizers, 48 pages.

Many of the back bulletins and reports are nearly or quite out of print. Parties having spare copies of any of the publications noted in the following list would confer a favor by returning the same, thus enabling the station to comply with requests from libraries, etc., and from other stations. The station will gladly refund postage.

Reports wanted; I, II, IV, VI, VII, VIII, X, XI.

Bulletins wanted; 1 to 8, 10 to 12, 14 to 16, 19, 31 to 34, 36 to 39, 40, 42, and 56.

CHANGES IN STATION STAFF AND EQUIPMENT

The director, who had been chemist of the station since its organization, relinquished the latter position January 1, 1899. Mr. C. H. Jones, assistant chemist since early in 1896, was elected to the vacancy.

Mr. W. A. Orton, assistant botanist, resigned his position at the close of the year to accept an appointment in the Division of vegetable pathology of the Department of agriculture at Washington. No other change in the staff has occurred and no important alterations or additions have been made to the equipment.

RELATION OF THE STATION TO THE PUBLIC

The station seeks to promote the agricultural interests of Vermont in a five-fold manner:

1. By the scientific investigation of matters pertaining to agriculture and the publication of the results of its experimental work in the form of bulletins and reports, and also, through the medium of the agricultural, scientific and general press.

2. By direct correspondence with individuals of all classes, particularly with farmers.

3. By the personal contact of members of the station staff with the farming community at institutes, fairs, through visitation, etc.

4. By analyzing miscellaneous agricultural material for residents of the state in accordance with section 263 of the Vermont statutes.

5. By so conducting its farming operations that visible and tangible evidence may be shown of the usefulness of science in agriculture; or, in other words, affording daily object lessons in good modern farming, based on scientific principles.

1. *Publications.*—The determination and dissemination of new and useful facts of an agricultural bearing is the main function of the station.

It makes an attempt to reach its constituency in many ways and it is felt that it is yearly becoming more useful. The passage of an act by the last legislature appropriating not to exceed one thousand dollars annually for printing the station report will permit of a larger use of printer's ink by the station than heretofore. This sum is a fair offset against expenses incurred in complying with section 263 of the Vermont statutes referred to under 4.

2. *Correspondence.*—This class of work continues to make serious inroads upon the time of the director and of other members of the staff. It is, however, a legitimate line of station service, helpful to the farmer, and is gladly undertaken.

3. *Institute work, etc.*—The personal contact of station workers and farmers is to be encouraged. In few ways can the results of station endeavors be brought home more directly to the farmer, or his needs and perplexities be more clearly realized by the scientist than by their meeting at the institute, in the field or by visitation. The station director has been an active member of the Board of agriculture for thirteen years and station representatives have addressed from 20 to 40 institutes annually.

4. *Miscellaneous analytical work.*—Section 263 of the Vermont statutes requires the station to analyze materials of an agricultural nature without charge to the citizens of Vermont. Parties intending to make use of the station in this way are respectfully referred to the statement in the announcement, page 119. Attention is called to the fact that the station no

longer makes water analyses, a class of work now done at the laboratory of the State board of health.

5. *The station farm.*—The station farm and buildings are open to the inspection of all who may be interested. Visitors are welcome on week days to look over buildings and stock. The kindly words of approval from thousands of visitors in the past show that the object lesson in good farming, the experiments which appeal to the eye, and the information elicited by direct questioning of those in charge alike prove helpful.

RELATION OF THE STATION TO THE STATE

The income of the station is derived from several sources, including the congressional grant, state printing appropriation, license fees from commercial fertilizer companies, inspection taxes on certain feeding-stuffs, creamery glassware and operators' fees, and from sales of farm produce. The financial reports showing the expenditure of several of these funds are printed on pages 122–123. Detailed statements concerning the workings of sundry state laws may be found in the text, pages 139–144, also bulletins 68–71. It is to be noted that the state laws require the station to do a class of work, which, while unquestionably of much value to the farming interests is held to be outside the province of the national enactment.

WORK OF THE YEAR

The only new line of work begun during the year, is an inquiry into the causes and treatment of abortion in cows. The limited income of the station and its well grounded policy of strengthening the important lines of work already in hand doubtless will prevent further expansion. Concise statements of the main results of station endeavor during the past year in the departments of chemistry, botany, horticulture, and dairy husbandry follow.

CHEMISTRY

Commercial fertilizers.—The station has analyzed 137 brands, the output of 18 companies.

Three-fourths of the brands were up to or above guaranty, one-fourth fell short somewhat, while one-tenth failed to furnish a commercial equivalent of their guaranties. While as a rule the quality of the crude stock used was good, there were some cases which seem open to criticism.

The average selling price approximated $28.75 and the average valuation, $17.39. Two dollars in every five paid for fertilizers met costs of manufacture and sale. In one third of the entire number of brands, a dollar was charged for amounts of plant food which might have been bought in the manner above stated at 55 cents or less.

The average composition of the brands sold is slightly lower than last year. Selling prices have dropped, and plant food is as cheap as it ever was.

The comparison of analyses of 133 brands for five years shows in some essential evenness and in others considerable variation in composition.—Bulletins 69-71, pages 42-116, also this report, pages 148–150.

BOTANY

Potato diseases.—Potatoes suffered severely in 1898 from tip-burn. The association of this trouble with protracted drought and flea beetle attacks was again made clear. One of the most important problems facing the potato grower is to provide against these two sources of danger. Plants sprayed with bordeaux mixture were relatively exempt from tip-burn. There was little damage from the fungus blights or rot; yet by this spraying the yield was increased from 112 to 239 bushels to the acre, or more than doubled. In these experiments three applications gave considerably better results than did two. Improperly made bordeaux mixture proved somewhat inferior and commercial mixtures decidedly inferior to the standard mixture. Bug death and laurel green were found to have some value as preventives of insect injuries to potatoes but their value as fungicides was not determined. Pages 151–155.

Studies upon the time and rate of development of the potato tuber were made along the lines of those begun in 1893. It was found that one-half of the marketable tubers were developed after August 24. The importance of this is evident when it is considered that most of the unsprayed plants were dead at this date and over one-half of the possible yield was lost. Pages 155–156.

Apple diseases.—Spraying Fameuse apples with bordeaux mixture for the prevention of the scab again proved to be exceedingly profitable. Four applications of fungicides were more profitable than a less number, but this matter of the most profitable number of applications will vary with seasons and circumstances. In 1899 two applications gave adquate protection. One of the most important observations is that the results of such spraying are *cumulative* so that less spraying is required in an orchard that has been well cared for in previous seasons.—Pages 156–157.

The brown spot of the apple is a disease especially troublesome on Baldwins. Investigation shows that it is not due either to fungi or to bacteria. It is associated with the vascular system of the fruit and is identical with the disease known in Germany as "Stippich-werden." Certain investigations have led the Germans to attribute this to concentration of the sap in certain areas as a result of the loss of water. The matter of remedies has not as yet been much worked upon but there is some evidence that spraying with bordeaux mixture will lessen the amount of spotting. Pages 159–164.

Vermont fungi.—A second partial list of the parasitic fungi of the state has been prepared in continuation of that published in the last report. These two lists include practically all of the parasitic species discovered in the state to the present time and will serve as a basis for future studies. Pages 164–182.

Killing weeds with chemicals.—The popular demand for more definite information regarding chemical weed killers led to a comparative test of a number of chemicals for killing weeds in walks, driveways, etc. The result shows the comparative inefficiency of salt, potassium sulphide, kerosene and copper sulphate. Crude carbolic acid proved to be very effective. Various arsenical solutions were equally effective and their action appeared to be more enduring. One of the best of these for practical purposes is arseniate of soda. Pages 182–188.

Various other lines of work are under way but the results are not as yet ready for publication.

HORTICULTURE

Plum pollination.—Continuing the work of former years investigations have been made of the conditions required by plums in order to make cross-pollination successful. Blossoming seasons have been further investigated, and it has been shown still more clearly that varieties blossom in a somewhat regular order in different years and different localities. This order is so nearly uniform that varieties may be adjusted to one another on the basis of the records of previous years. Some sketch is made also of the mutual affinities exhibited by the different varieties in cross-pollination. Varieties differ also in the amount of pollen produced, but all usually produce enough to effect pollination, providing other conditions are suitable. A tree used as a pollenizer must also bear good fruit itself. All these conditions are taken into one view in a table of recommended pollenizers. Further experiment shows the great importance of the honey bee in carrying pollen. The so-called June drop of plums is found to be due to three principal causes: non-pollination, curculio work, and the struggle for existence.—Pages 189–209.

European plums.—The European plums, or Domesticas, have been given a special study, and it is pointed out that the group contains several distinguishable types, as follows: The Myrobalan, the Damsons, the Reine Claude type, the Dame Aubert type, the Prunes, the Perdrigons, the Diamond type, the Bradshaw type, and the Lombard type.—Pages 210–218.

Hybrid plums.—A second report is made on hybrid plums, consisting chiefly of descriptions of new hybrid varieties. It is found that some classes of plums are taking a much more prominent part in the production of hybrids than are others. The Japanese plums are the most conspicuous of all. After these come the Hortulanas and the Chicasaws, while the Americanas and the Domesticas are hardly represented.—Pages 218–230.

Variation in the genus Prunus.—The study of the native species of plums and their allies has been found necessary to the experimental work which the station has been doing with cultivated plums. This study has shown (1) that a striking parallelism of modification obtains amongst the several species; (2) that this modification is closely related to geographical distribution; (3) that a uniform system of nomenclature is desirable. A revision of species and variety names has been made accordingly.—Pages 231–239.

Cherries.—Cherries have been found comparatively successful and easy to grow. The new russian varieties have done well. The leading old and new varieties are described, and the following are recommended: Morello, Montmorency, Brusseler Braun, Wragg, Bessarabian, Schatten Amarelle, Griotte du Nord, Juneat Amarelle. Directions for culture are given.—Pages 240–251.

DAIRYING

Feeding Tests and their methods.—The problems studied were as follows:

(*a*) The variation in production following the use of dissimilar rations affording food supplies equal in total amount and in the amounts of the different nutrients,

(*b*) The effect upon production of the addition to the ration of liquid fat, emulsified or unemulsified,

(*c*) The variation in production following the use of two rations affording food supplies equal in total amount but unequal in the amounts of the different nutrients,

(*d*) The variation in production following the use of two rations affording unequal food supplies, one being particularly deficient in protein,

(*e*) The feeding values of buckwheat middlings compared with half and half cottonseed and linseed meals; also compared with corn and bran,

(*f*) The feeding value of the improved french white artichoke compared with silage,

(*g*) The effect upon production of drinking at will as compared with watering at stated intervals,

(*h*) The effect upon production of grooming cows,

(*i*) The extent of experimental error in feeding tests.

The results were briefly as follows:

(*a*) The outcome of three years' trials of rations having equal nutritive ratios but different composition indicates that uniform production is not to be expected of necessity when there are eaten equal amounts of digestible nutrients derived from divers sources.—Pages 202-269.

(*b*) Milk yields to the unit of dry matter eaten were always increased when oil was fed, the increase amounting to from 3 to 9 per cent. The amount of total solids and fat was increased by the cottonseed oil feeding from 2 to 15 per cent, on linseed oil feeding 2 per cent and on corn oil feeding not at all. The quality of milk was always improved at the outset of

this class of feeding but quickly returned to normal quality or became poorer than usual when corn or linseed oils were fed. The increased fat percentage—unaccompanied by rise in the percentage of solids-not-fat—was fairly permanent, lasting from 4 to 6 weeks at least, when either raw or emulsified cottonseed oil was used. Since the same changes were brought about when raw oil was fed as followed the use of emulsified oil, it is safe to say that in these trials emulsifying was without influence as a means of feeding fat into milk.—Pages 269–275.

(*c*) More milk was given—7 per cent—on a ration having a medium nutritive ratio than on one having a wide ratio but affording the same total amount of food. The quality of the milk was unchanged.—Pages 276–279.

(*d*) A scant ration, particularly deficient in protein, produced 5 per-cent less and slightly richer milk, than a medium ration.

(*e*) When buckwheat middlings were fed a unit of dry matter produced about 3 per cent less milk, solids and fat, than when ration No. 1, was used, or about 4 per cent more than when corn and bran were fed. The quality of the milk was generally uniform.—Pages 279–282.

(*f*) Hay, silage and mixed feed No. 1 were fed to one cow against hay, artichoke tubers and mixed feed No. 1. To the unit of dry matter eaten 10 per cent less milk was made on the silage ration.—Pages 282-283.

(*g*) Cows fed a uniform ration were in alternating periods watered at will or at intervals, and in the former case made 2 per cent more milk. The effect upon quality cannot be stated.—Pages 283-285.

(*h*) Cows fed a uniform ration were in alternating periods groomed or left uncarded without appreciable effect either upon milk yield or quality. —Pages 285-286.

(*i*) Uniform rations were fed and uniform production ensued. A unit of dry matter made essentially the same milk, solids and fat at one time as another, lactation changes being equalized. It is probably unsafe to lay stress on apparent differences in feeding values of much less than 5 per cent.—Pages 286-287.

In a test of the relative value of various grain rations Buffalo gluten meal proved superior to the others, the cottonseed-linseed ration ranking second.—Pages 288-293.

Quality of butter.—When emulsified oils were fed to cows the butter made resembled admixtures of butter with the oils, making the cow essentially an accomplice in adulterating butter. The milks made when linseed and corn oils were fed creamed and churned less exhaustively than did that made when cottonseed oil was fed.—Pages 296–298.

Herd record.—The usual record of the dairy doings of the station herd showed an average production for 42 cows of 5296 pounds of milk and 313 pounds of butter, with extremes of 8045 and 2344 pounds of milk, 454 and

130 pounds of butter. It cost for food from 11 to 28 cents a pound to make a pound of butter.—Pages 299–307.

Forage crops.—Certain non-saccharine sorgham made poor growths and two leguiminous crops, a fair growth.—Page 308.

Effect of fatigue.—Fatigue was found temporarily to enrich the quality of milk.—Page 309.

PUBLICATIONS ON HAND

The station has issued to July 1, including the present number, 12 annual reports and 71 bulletins. Many of these are out of print. The following numbers are in print, and will be sent on request without charge as long as the supply lasts.

Attention is called to the list of reports and bulletins wanted by the station given on page 124 of the present report.

1888, April	No. 9, Smut in Oats, Insecitides and Fertilizers	8 pages
November.	No. 13, Methods of Cutting and Planting Potatoes; Fertilizer Analses	12 pages
1889, October.	No. 17, Test of Dairy Cows at Vermont State Fair	18 pages
	Third Annual Report	172 pages
1890, January.	No. 18, Pig Feeding	20 pages
May.	No. 20, Analyses of Fertilizers Licensed for Sale in the State of Vermont for the year 1890	16 pages
September.	No. 21, A New Milk Test; Testing Milk at Creameries and Cheese Factories; Notes for the Laboratory	32 pages
October.	No. 22, Test of Dairy Cows; Home vs. Fair Grounds	12 pages
1891, March.	No. 23, Analyses of Fertilizers Licensed for Sale in the State of Vermont for the year 1891	16 pages
May.	No. 24, Potato Blight and Rot	16 pages
June.	No. 25, The Bounty on Maple Sugar	4 pages
September.	No. 26, Maple Sugar	24 pages
	Fifth Annual Report	168 pages
1892, January.	No. 27, Tests of Dairy Apparatus	12 pages
April.	No. 28, Plant Diseases	24 pages
May.	No. 29, Analyses of Fertilizers Licensed for Sale in the State of Vermont for the year 1892	12 pages
June.	No. 30, The Result of the Bounty on Maple Sugar	8 pages
1893, May.	No. 35, Analyses of Fertilizers Licensed for Sale in the State of Vermont for the year 1893	16 pages
December.	No. 40, Spraying Potatoes	20 pages
1894, May.	No. 41, Analyses of Commercial Fertilizers	16 pages
November.	No. 43, Household Pests	8 pages
December.	No. 44, Spraying Orchards and Potato Fields	28 pages
1895, March.	No. 45, Analyses of Commercial Fertilizers	8 pages
	No. 46, Analyses of Commercial Fertilizers	16 pages
May.	No. 47, Commercial Fertilizers	40 pages
October.	No. 48, Gluten Feeds and Meals	20 pages
December.	No. 49, Potato Blights and Fungicides	24 pages

1896, March.	No. 50, Analyses of Commercial Fertilizers	7 pages
April.	No. 51, Analyses of Commercial Fertilizers	12 pages
May.	No. 52, Analyses of Commercial Fertilizers	24 pages
August.	No. 53, The Pollination of Plums	20 pages
	Ninth Annual Report	240 pages
November.	No. 54, Salad Plants and Plant Salads	16 pages
December.	No. 55, Apple Growing in Grand Isle County	16 pages
1897, March.	No. 57, Analyses of Commercial Fertilizers	16 pages
April.	No. 58, Analyses of Commercial Fertilizers	16 pages
May.	No. 59, Analyses of Commercial Fertilizers	32 pages
October.	No. 60, Insects of the Year	16 pages
November.	No. 61, Hardy Apples for Cold Climates	16 pages
1898, January.	No. 62, Homes Grown Grapes in Vermont	16 pages
March.	No. 63, Analyses of Commercial Fertilizers	16 pages
April.	No. 64, Analyses of Commercial Fertilizers	16 pages
May.	No. 65, Analyses of Commercial Fertilizers	48 pages
September.	No. 66, Club-root and Black Rot of the Cabbage	16 pages
December.	No. 67, Hybrid Plums	30 pages
1899, January.	No. 68, Inspection of Milk Tests and Feeding Stuffs	8 pages
March.	No. 69, Analyses of Commercial Fertilizers	16 pages
April.	No. 70, Analyses of Commercial Fertilizers	16 pages
May.	No. 71, Analyses of Commercial Fertilizers	48 pages
September.	No. 72, Certain Potato Diseases and their Remedies	32 pages
October.	No. 73, The Trees of Vermont	54 pages
December.	No. 74, The Home Fruit Garden	12 pages
1900, January.	No. 75, Check List of Hybrid Plums	12 pages

ABSTRACTS OF BULLETINS

Bulletin No. 66—Club Root and Black Rot—Two Diseases of the Cabbage and Turnip

By L. R. Jones

SUMMARY

I. Club-root and black rot, destructive diseases of the cabbage, turnip and allied plants, are threatening to become widespread in Vermont. They are easily suppressed if taken in season.

II. Club-root is a curious malformation of the roots, which ruins the plants by preventing the absorption of water and foods. It was probably introduced into this country from Europe, and is spreading. It has been observed in Vermont only recently.

Clubbing of roots is due to their invasion by a parasite which stimulates them to abnormal growth. This parasite once established in the soil is very difficult to exterminate.

The parasite is perpetuated over winter by spores which are formed in vast numbers in the clubbed roots.

These germs pass uninjured into the manure of the stock fed upon clubbed roots, and the use of such infected manure is one of the commonest ways of introducing the germs into the soil. Another way is with roots transplanted from infested soil.

The disease attacks numerous plants of the mustard family, including various common garden vegetables, flowers and weeds. This aids in its spread and perpetuation. It can, however, live a number of years in the soil independently of any host plant.

Remedial measures.—1. Remove all clubbed roots from the field and destroy them by burning or burial, or boil them if to be fed to stock. 2. Plow infected soil deeply. 3. Rotate crops. 4. Suppress all weeds of the mustard family. 5. Apply lime, 75—150 bushels per acre, in autumn before planting cabbages or turnips.

III. *Black rot of cabbages, etc.*—A recently recognized disease has been observed in numerous Vermont fields.

It is caused by bacteria, which invade the vessels of leaves and stem. The diseased plants are weakened or die of a sort of dry rot. The blackened condition of the invaded veins is the surest sign of the disease. It is not to be confused with the common wet rot.

The germs pass the winter in the soil, or in the manure if diseased plants are fed to stock. They re-enter the cabbage plants through the water pores or insect punctures.

Remedial measures.—1. Rotation of crops. 2. Care in selection of manure. 3. Suppression of cabbage insects. 4. Removal and destruction of spotted leaves in the early stages of the disease and of entire plants if the stem is invaded.

Bulletin No. 67.—Hybrid Plums

BY F. A. WAUGH

SUMMARY

I. 1. Descriptive and historical notes are given of fifty varieties of plums which have been supposed to be of hybrid origin. A few of these are doubtless not hybrids, though the large majority probably are.

2. There are also certain large groups of plums growing wild in North America which seem to be of hybrid origin, the most important being the Wildgoose, Wayland and Miner groups. Even under cultivation hybrids seem to occur in groups.

II. 1. Among cultivated plums intermediateness of character is the best test of hybridity. While the pedigree record is not to be ignored, it is seldom reliable, and must always depend upon the test of intermediateness for its verification. The test of distribution can not be applied.

2. A hybrid plum is to be classified by referring it to the several species whose characters it bears, rather than by reference to its pedigree.

3. Hybridity seems to be quite common among plums. All species may be intercrossed. The Japanese plums cross with the Chicasaws and the Hortulanas with especial ease. The Domesticas and Americanas cross with other groups with greater difficulty. Plums also cross with various cherries, peaches and apricots.

4. Each species has its peculiar value in plum breeding, and certain combinations are more promising than others.

5. The hybrid plums are likely to be eventually of great importance in fruit growing. Their introduction promises to mark an epoch in plum culture. Many of the varieties already produced are very promising, but none has yet been tested widely enough to warrant its general recommendation.

Bulletin No. 68—Inspections of Milk-Tests and Feeding-Stuffs

BY J. L. HILLS

(See articles on concentrated feeding stuffs, pages 139-143, and the milk test inspection law, pages 143-145.)

Bulletins Nos. 69, 70 and 71—Analyses of Commercial Fertilizers

BY J. L. HILLS C. H. JONES AND B. O. WHITE

SUMMARY

I. The trade values for 1899 per pound of the ingredients as found in mixed goods are as follows: Ammoniacal, nitrate and organic nitrogens, 15, 12½ and 14 cents respectively; soluble, reverted and insoluble phosphoric acids, 4½, 4 and 2 cents respectively; potash, as sulphate, 5 cents, as muriate, 4½ cents. It should be particularly noted, however, that these trade values do not represent the proper selling prices of mixed goods at the point of consumption, but are the retail trade values or cash costs of amounts of nitrogen, phosphoric acid and potash, equal to those contained in a ton of the brand in question, in standard unmixed raw materials of good quality, at the seaboard. They do not include freight, cost of manufacture, storage, commissions, etc. They stand in no necessary relation to the profits derived from the use of the goods, but have a purely commercial significance.

II. The station has analyzed 137 brands, the output of eighteen companies, all drawn from dealers' stocks, all this year's goods.

1. Quantity of plant food furnished.—Three fourths of the brands were up to or above guaranty, one fourth fell short somewhat, while one tenth failed to furnish a commercial equivalent of their guaranties. A few cases of deficiency were serious. The percentage of failure to meet claims is greater than has been found of late years.

2. Quality of plant food furnished.—While as a rule the quality of the crude stock used was good, there were some cases which seem open to criticism. Two fifths of the brands carried no water-soluble nitrogen. Laboratory methods seem to indicate that somewhat inferior forms of nitrogen were used in certain cases, notably in some low grade goods and by some companies. The phosphoric acid was in some cases quite largely in the insoluble or reverted forms, indicating apparently either imperfect manufacture, old goods, or more or less use of (agriculturally) inferior forms of this ingredient. Sulphate of potash is claimed to be present in nine-tenths of the brands, but was actually found in less than one-eighth of the entire number.

3. Selling prices and valuations.—The average selling price approximated $28.75 and the average valuation, $17.39. Two dollars in every five paid for fertilizers met cost of manufacture and sale. The same amount of plant food which cost a dollar might have been bought at retail for cash at the seaboard for 56 cents in average low priced goods, for 61 cents in average medium grade brands, and for 66 cents in average high priced goods. In one third of the entire number of brands, a dollar was charged

for amounts of plant food which might have been bought in the manner above stated for 55 cents or less. "Cheap fertilizers" are usually the most expensive to buy.

III. *The average composition* of the brands sold is slightly lower than last year. Selling prices have dropped, and plant food is as cheap as it ever was. Notwithstanding these facts, buying mixed goods on time is still a far more costly method of getting plant food than is home mixing or buying on special order.

IV. *The comparison of analyses of 133 brands for five years* shows in some essential evenness and in others considerable variation in composition. The tables showing composition for five years should prove helpful to the early buyer of mixed goods.

REPORT OF THE CHEMISTS

C. H. JONES AND B. O. WHITE

The work of the chemists differs from that of the other members of the scientific staff, in that it contributes largely to matter printed under headings other than its own. Much of the work that is scheduled under "Dairying" is done in the chemical laboratory, and considerable time has likewise been given to analyses of interest in botanical and horticultural investigations. The entire work of three months upon fertilizer analyses fills but a single page in this volume and that under another heading. Hence the matter printed under this caption represents but a small fraction of the actual working time of the chemists.

Much time has been spent on investigations as yet unfinished. The more important problems in hand include chemical studies of maple sap, of the artichoke plant and tuber and of the potato tuber dug at intervals from early August to the middle of October.

The subject matter of the present report is discussed under the following headings :

Further notes on organic nitrogen availability.
Concentrated feeding-stuffs.
- I. Feeding-stuffs inspection.
- II. Analyses.

The "milk-test inspection law."
Miscellaneous analyses.
- I. Drinking water.
- II. Sugar beets.
- III. Insecticides, etc.
- IV. Fertilizers.

FURTHER NOTES ON ORGANIC NITROGEN AVAILABILITY

A modification of the alkaline-permanganate method for determining the availability of organic nitrogen in fertilizers was proposed and discussed at length in the last report.[1] The method as modified was shown to be capable of making broad distinctions between animal ammoniates of high and low nitrogen availabilities, and to be simple, rapid, and, as an indicative method, highly useful. Eighteen different ammoniates were tabulated and described and their nitrogen availabilities determined, (*a*) using equal quantities of material and (*b*) using equal amounts of nitrogen (.045 grams).

It has been thought desirable to extend our knowledge of the capabilities and limitations of this method ; hence, as time and opportunity have permitted during the year, other ammoniates, 18 in number, have been tested.[2]

1 Vt. Sta. Rpt. 11, pp. 160–171 (1898).

2 These goods have been secured mainly through the courtesy of Mr. F. B. Carpenter, chemist of the Virginia-Carolina Chemical Co., Richmond, Va.; Mr. C. S. Crocker, chemist of the L. B. Darling Co., Pawtucket, R. I., and Mr. E. B. Holland, assistant chemist of the Hatch experiment station, Amherst, Mass.

The following table shows the 18 materials tried this year, together with reference number and percentages:

Reference number	Material	Nitrogen percentage
4	Acidulated fish	6.72
6	Tankage	6.43
7	High grade tankage	8.33
8	Concentrated tankage	12.99
9	Dissolved tankage	4.51
10	Hair tankage, wool, horn, meat, etc.	9.10
11	Garbage tankage, New York	3.15
12	" " St. Louis	4.76
13	" " "	2.11
18	Dissolved horn and hoof	11.13
19	Hog bristles	11.20
20	Hair	9.82
26	Fertilizer containing cotton-seed meal as its sole source of nitrogen,	2.15
27	Cottonseed meal	1.72
30	Cream gluten meal	5.87
31	Gluton meal	1.75
33	Atlantic gluten meal	12.43
34	Cocoanut fiber feed	3.63

The following table shows the results obtained with the 36 ammoniates by the alkaline-permanganate treatment:

NITROGEN AVAILABILITIES USING (*a*) EQUAL QUANTITIES OF MATERIAL, (*b*) EQUAL AMOUNTS OF NITROGEN (.045 GRAMS)

MATERIALS	Per cent of nitrogen	(*a*) Grams used	(*a*) Per cent of nitrogen available	(*a*) Availability per cent	(*b*) Grams used	(*b*) Equivalent to per cent of nitrogen	(*b*) Per cent of nitrogen available	(*b*) Availability per cent
ANIMAL AMMONIATES								
1. Dried blood	13.71	1	3.95	28.8	0.333	4.57	3.12	68.3
2. Ground bone	3.33	1	2.42	72.6	1.333	4.44	2.94	66.2
3. Dried fish	6.93	1	3.15	45.5	0.666	4.62	3.16	68.5
4. Acidulated fish	6.72	1	3.50	52.1	0.67	4.50	2.77	61.6
5. Tankage	5.18	1	2.31	44.6	0.90	4.66	2.61	56.0
6. Tankage	6.43	1	3.40	52.9	0.70	4.50	2.76	61.3
7. High grade tankage	8.33	1	3.11	37.3	0.54	4.5	2.72	60.4
8. Concentrated tankage	12.99	1	4.55	35.0	0.34	4.42	3.25	73.5
9. Dissolved tankage	4.51	1	2.67	59.3	1.00	4.51	2.67	59.3
10. Hair tankage, wool, horn, meat, etc	9.10	1	3.12	34.3	0.50	4.55	2.66	58.5
11. Garbage tankage (New York)	3.15	1	0.87	27.6	1.4	4.41	1.12	25.4
12. Garbage tankage (St. Louis)	4.76	1	1.23	25.8	0.95	4.52	1.36	30.1
13. Garbage tankage	2.11	1	0.70	33.1	2.15	4.54	0.80	17.6
14. Philadelphia tankage	7.07	1	1.23	17.4	0.62	4.38	1.30	29.7
15. Hoof meal	13.65	1	4.55	33.3	0.333	4.55	3.11	68.3
16. Horn meal	14.53	1	4.49	30.9	0.310	4.50	2.67	59.4
17. Horn shavings	14.39	1	4.65	32.3	0.310	4.46	2.88	64.6
18. Dissolved horn and hoof	11.13	1	4.84	43.5	0.40	4.45	2.91	65.4
19. Hog bristles	11.20	1	3.89	34.7	0.40	4.48	3.11	69.4
20. Hair	9.82	1	3.67	37.4	0.46	4.52	2.59	57.3
21. Wool waste	4.94	1	1.71	34.5	0.90	4.45	1.82	41.0
22. Leather	7.51	1	1.16	15.6	0.60	4.50	1.47	32.7
23. Leather refuse	7.29	1	1.43	19 5	0.61	4.45	1.33	30.0
24. Casein	12.36	1	3.30	26.7	0.36	4.45	2.59	58.2
VEGETABLE AMMONIATES								
25. Cottonseed meal	6.90	1	1.81	26.4	0.666	4.60	2.13	46.3
26. Cottonseed meal fertilizer	2.15	1	1.57	72.9	2.10	4.52	3.04	67.2
27. Cottonseed meal fertilizer	1.72	1	1.11	64.5	2.60	4.47	2.44	54.6
28. Flax meal	6.41	1	2.17	33.8	0.70	4.49	2.03	45.2
29. Gluten meal	6.55	1	1.76	26.5	0.68	4.52	2.09	46.0
30. Cream gluten meal	5.87	1	1.37	23.3	0.76	4.46	1.33	29.8
31. Gluton	1.75	1	0.39	22.3	2.60	4.55	0.94	20.7
32. Castor pomace	5.70	1	2.52	44.2	0.80	4.56	2.73	60.0
33. Atlantic gluten meal	12.43	1	4.64	37.3	0.36	4.47	3.14	70.2
34. Cocoanut fiber feed	3.63	1	0.71	19.7	1.24	4.50	0.91	20.2
35. Felt refuse	4.55	1	2.24	49.2	1.00	4.55	2.31	50.8
36. Muck	1.57	1	0.52	33.0	2.80	4.40	0.94	21.3

The misleading results obtained with equal quantities of material but unequal weights of nitrogen are as evident in this as in last year's work. When, however, equal amounts of nitrogen are taken (modified method) useful results are attained.

Animal ammoniates.—Not one of the better forms shows less than 56 per cent availability by the modified method while the garbage and Philadelphia tankages, woolwaste, leather and leather refuse, all of which are of well-known inferiority as fertilizers, show from 41 to 18 per cent availability. Hair tankage and hog bristles range unexpectedly high.

Vegetable ammoniates.—The modified method was found in last year's experience less satisfactory with vegetable than with animal ammoniates. It seemed probable that the low availability found with cottonseed, flax and gluten meals, materials well known to be effective in actual field use, was due to the relatively large content of non-nitrogenous organic matter. This conjecture was borne out by the lowered results on high grade animal ammoniates, when filterpaper, starch, etc., were digested with them as well as by the higher figures obtained with a vegetable ammoniate after it has been acidulated for many months. In order to throw more light upon this question a highly proteinous vegetable by-product, Atlantic gluten meal, was secured. This material carried 7.04 per cent moisture, 0.42 per cent crude ash, 77.69 per cent crude protein, 0.24 per cent crude fibre, 13.59 per cent nitrogen free extract, and 1.02 per cent ether extract. Although belonging to the same class of material as the other glutens, it showed 70.2 per cent nitrogen availability instead of 46 and 30 per cents. It seems safe to ascribe this result to the low percentage (14.85) of non-nitrogenous organic matter.

It was pointed out in the last report that the more tedious pepsin-digestion process, which should be used as an adjunct to the modified permanganate method and in all cases of doubt, does justice to vegetable ammoniates.

CONCENTRATED FEEDING STUFFS

I. FEEDING STUFF INSPECTION

Attention was called in the last report to the need of some form of control over the quality of the feeding stuffs for farm animals sold in the state. The arguments in favor thereof were stated to be that:

1. The trade involves enormous sums. Approximately $3,500,000 is expended in Vermont each year for feeding-stuffs for domestic animals.

2. The feeding stuffs sold are of many kinds, they often bear misleading names, and their selling prices are no certain index of their value as feeds.

3. Different feeding stuffs vary largely in composition one from another while those of the same name may be widely apart in feeding values

owing to the differences brought about by (*a*) variations in the composition of the material from which they are derived; (*b*) by differences or changes in methods of manufacture; (*c*) by adulteration.

4. Guaranteed compositions would tend to insure better values, wiser purchases and greater confidence. A feeding stuff control would aid in money saving and be of distinct educational advantage.

All the arguments favoring a control of the sale of commercial fertilizers are applicable to the present case.

The general idea received the endorsement of many farmers and the enactment passed the general assembly without opposition. It requires manufacturers to state plainly the quality of their goods and provides means whereby their promises and doings may be impartially compared. The text of the law is as follows:

No. 83.

AN ACT TO REGULATE THE SALE OF CONCENTRATED COMMERCIAL FEEDING STUFFS

It is hereby enacted by the General Assembly of the State of Vermont:

Section 1. Every lot or parcel of any concentrated commercial feeding stuff, as defined in section three of this act, used for feeding farm live stock, sold, offered or exposed for sale in the State of Vermont, shall, in addition to the tax tag described in section five of this act, have affixed thereunto, in a conspicuous place on the outside thereof, a plainly printed statement clearly and truly certifying the number of net pounds of feeding-stuff in a package, the name, brand or trade mark under which the article is sold, the name and address of the manufacturer or importer, the place of manufacture, and a chemical analysis stating the percentages it contains, of crude protein, allowing one per cent. of nitrogen to equal six and one-fourth per cent. of protein, and of crude fat, both constituents to be determined by the methods adopted at the time by the Association of Official Agricultural Chemists; provided that the statement of the percentage of crude fat may be omitted if it does not exceed three per cent.

Section 2. The term concentrated commercial feeding-stuff, as here used, shall not include hays and straws, the whole seed nor the unmixed meals made directly from the entire grains of wheat, rye, barley, oats, Indian corn, buckwheat and broom corn. Neither shall it include wheat, rye and buckwheat brans or middlings, nor pure grains ground together, nor wheat bran or middlings mixed together or with other feed.

Section 3. The term concentrated commercial feeding stuff, as here used, shall include linseed meals, cottonseed meals, pea meals, cocoanut meals, gluten meals, gluten feeds, maize feeds, starch feeds, sugar feeds, dried brewer's grains, malt sprouts, hominy feeds, cerealine feeds, rice meals, oat feeds, corn and oat chops, corn and oat feeds, ground beef or fish, mixed feeds, provenders, and all other materials of a similar nature not included within section two of this act.

Section 4. Before any concentrated commercial feeding-stuff, as defined in section three of this act, is sold, offered or exposed for sale, the importer, manufacturer or party who causes it to be sold or offers it for sale within the State of Vermont, shall, for each and every feeding stuff bearing a distinguishing name and trade mark, file with the director of the Vermont Agricultural Experiment Station a certified copy of the statement named in section one of this act, and shall also deposit with said director, at his request, a sealed glass jar or bottle containing not less than one pound of the feeding-stuff to be sold or offered for sale, accompanied by an affidavit that it is a fair average sample thereof and corresponds within reasonable limits to the feeding-stuff which it represents in the percentage of protein and fat which it contains.

Section 5. The manufacturer, importer, agent or seller of each concentrated commercial feeding-stuff as defined in section three of this act, shall, before the article is offered for sale, pay to the director of the Vermont Agricultural Experiment Station an inspection tax of ten cents per ton for each ton of such concentrated feeding-stuff sold or offered for sale in the State of Vermont, and shall affix to each car shipped in bulk and to each bag, barrel or other package of such concentrated feeding-stuff, a tag to be furnished by said director, stating that all charges specified in this section have been paid. The director of said experiment station is hereby empowered to prescribe the forms for such tags, and adopt such regulations as may be necessary for the enforcement of the law. Whenever the manufacturer or importer or shipper of a concentrated feeding-stuff shall have filed the statement made in section one of this act and paid the inspection tax, no agent or seller of said manufacturer, importer or shipper shall be required to file such statement or pay such

tax. The amount of inspection tax received by said director shall be paid by him to the state treasurer. So much of the inspection tax collected under this act shall be paid by the state treasurer to the treasurer of said experiment station as the director of said experiment station may show by his bills has been expended in performing the duties required by this act, but in no case to exceed the amount of the inspection tax received by the state treasurer under this act, such payment to be made quarterly upon the order of the auditor of accounts, who is hereby directed to draw his order for such purpose.

Section 6. Any manufacturer, importer, agent or person selling, offering or exposing for sale any concentrated commercial feeding-stuff, as defined in section three of this act, without the statement required by section one and the tax tag required by section five of this act, or with a label stating that said feeding-stuff contains substantially a larger percentage of either of the constituents mentioned in section one than is contained therein, shall on conviction in a court of competent jurisdiction be fined not more than fifty dollars for the first offence, and not more than one hundred dollars for each subsequent offence.

Section 7. All manufacturers and importers of concentrated commercial feeding-stuffs, or dealers in the same, shall, when requested, furnish the director of the Vermont Agricultural Experiment Station with a complete list of the names or trade marks of said feeding-stuffs, and all agents selling, offering or exposing the same for sale.

Section 8. The director of the Vermont Agricultural Experiment Station shall cause one analysis or more to be made annually of each concentrated commercial feeding-stuff sold or offered for sale under the provisions of this act. Said director is hereby authorized in person or by deputy to take a sample not exceeding two pounds in weight for analysis from any lot or package of concentrated commercial feeding-stuff which may be in the possession of any manufacturer, importer, agent or dealer in this State; but said sample shall be drawn in the presence of said party or parties in interest, or their representative, and shall be taken from a parcel or number of packages which shall not be less than five per cent. of the whole lot inspected, and shall be thoroughly mixed and divided into two equal samples and placed in glass or metal vessels, carefully sealed and a label placed on each stating the name or brand of the feeding-stuff or material sampled, the name of the party from whose stock the sample was drawn, and the time and place of drawing, and said label shall be signed by the director or his deputy and the parties or party in interest, or their representative, present at the drawing and sealing of said sample; one of said duplicate samples shall be retained by the director and the other by the party whose stock was sampled, and the sample or samples retained by the director shall be for comparison with the certified statements named in sections one and four of this act. The result of the analysis of the sample or samples so procured, together with such additional information as circumstances advise shall be published in reports or bulletins from time to time.

Section 9. The director of the Vermont Agricultural Experiment Station shall notify the state treasurer of all violations of this act, and the state treasurer shall commence a suit in the name of the state against the party or parties thus reported. It shall be the duty of the treasurer upon ascertaining any violation of this act to forthwith notify the manufacturers and importers, in writing, and to give them not less than thirty days thereafter in which to comply with the requirements of this act. But there shall be no prosecution in relation to the quality of any concentrated commercial feeding-stuff if the same shall be found to be substantially equivalent to the statement of analysis made by the manufacturers or importers.

Section 10. The term importer, for all the purposes of this act, shall be taken to mean all who procure or sell concentrated commercial feeding-stuffs.

Section 11. All acts or parts of acts inconsistent with this act are hereby repealed.

Section 12. This act shall take effect July 1st, 1899.

Approved November 29, 1898.

The essentials of the law may be concisely stated as follows:

Section 1 provides that all packages of "concentrated commercial feeding-stuffs" sold in Vermont shall bear a statement of the weight, name of goods, name and address of manufacturer and percentages of crude protein and of crude fat.

Sections 2 and 3 respectively define what materials are not and what are held to be, for the purposes of the law, "concentrated commercial feeding-stuffs."

Sections 4 and 7 provide for filing copies of guaranteed analyses, lists of feeds offered and agents selling same, by the manufacturers at the director's request.

Section 5 provides that the "manufacturer, importer or seller" (the latter two only in case the manufacturer fails to comply with the law,) shall pay to the director a tax of 10 cents a ton to cover costs of inspection and shall affix to each package a tag to be furnished by the director, stating that all charges have been paid; empowers the director to make regulations in the enforcement of the law; provides for the payment of its receipts to the state treasurer and for the reimbursement of the station for expenses incurred.

Section 6 is a penal section.

Section 8 provides for the sampling of the material in the hands of the seller; also that one or more analyses of each goods be made annually and the results thereof published together with such additional information as seems advisable.

Section 9 prescribes action in case of violation and defines violation of the act so far as it relates to the quality of the goods.

Section 10 defines the word "importer."

Section 11 is a repealing section.

Section 12 states that "this act shall take effect July 1, 1899."

This law differs only in minor particulars of phraseology from the Maine law, and, except as regards method of raising revenue, is essentially like the laws of Massachusetts, Rhode Island, Connecticut and New York. The general enactment of this law in the northeastern states has aroused antagonism on the part of certain manufacturers and has resulted in some friction. The need of the buyer for some such protection is becoming more evident as investigation proceeds and it is confidently believed that as its working becomes clear the law will approve itself to the legitimate trade and to the farmer. It is expected to issue two or three bulletins yearly giving the results of feeding-stuff inspections. The first one will be distributed during the coming winter.

II. ANALYSES

Sundry feeding stuffs have been sent in during the year for analysis, and are listed on the next page.

FEEDING STUFFS

MATERIAL	FROM	Water	Crude ash	Crude protein	Crude fiber	Nitrogen free extract	Ether extract
Cottonseed meal	D. A. Kneeland, Waitsfield	6.95	7.25	43.63	3.88	23.36	14.93
" " "	U. A. Goss, St. Johnsbury	5.45	6.98	46.57	5.40	25.97	9.63
" " "	" " " "	5.05	7.13	45.57	5.50	26.82	9.93
Cream gluten meal	W. E. Dennis, Boston, Mass	4.20	0.93	36.69	2.33	51.22	4.63
" " "	F. J. Libby, Newport	--	--	31.94	--	--	2.57
King gluten meal	" "	--	--	33.75	--	--	4.27
" " "	Andrew Cullen & Co., N. Y. City	7.48	--	33.13	--	--	4.82
Marshalltown gluten feed	E. O. Aldrich, Shrewsbury	--	--	25.75	--	--	3.05
Cocoanut fiber feed	W. E. Dennis, Boston, Mass	6.90	5.39	22.69	9.18	39.81	16.03
Calf meal	T. F. McDonald, Ludlow	--	--	24.50	--	--	4.29
Middlings	D. F. Robinson, Pawlet	--	--	17.25	--	--	5.88
Quaker oat feed	C. P. Smith, Burlington	7.67	5.57	11.13	15.65	56.06	3 92
Friends conc. dairy feed	Muscatine Oatmeal Co., Muscatine, Iowa	6.25	--	6.75	--	--	3.25
Horse feed	Whipple, Thompson & Co., Saxton's River	10.75	--	8.56	--	--	4.15
Hen feed	Whipple, Thompson & Co., Saxton's River	11.00	--	9.00	--	--	4.12
Gluten feed	F. Hall & Son, Lyndon	9.18	1.33	10.94	12.93	58.24	7.38
No. 1, (corn 2, oats 1)	Chandler & Porter, Wilmington	11.25	1.18	8.56	1.63	73.50	3.88
No. 2, (chopfeed)	" " "	11.15	1.98	8.56	6.38	65.85	6.08
Baum's stock food	J. N. Perrin, Berlin	7.28	12.48	24.59	19.64	27.73	8.28
Rape seed(ground)	" " "	4.15	6.83	17.00	10.53	30.15	31.34

Most of these materials are standard goods. Remarks seem in order concerning a few relatively new materials.

Cocoanut fiber feed.—This feed is very rich in fat and fairly so in protein, and is offered as yet in only a limited way.

Gluton feed.—This material is sold at a low rate in a more or less moist condition at Oswego, N. Y. It is a refuse from starch works, and even when dry is relatively poor in protein. It is not wise to ship it in its wet condition on account of fermentation. This gluton feed should not be confounded with gluten feed, which is another thing.

Baum's stock food.—This material, viewed solely as a food, has much less value than several of the concentrates on the market sold at much lower figures. It is stated by the Connecticut station to consist mainly of linseed meal, charcoal, sulphur and salt.

THE "MILK TEST INSPECTION LAW"

The legislature of 1898 passed a law requiring that all Babcock glassware used at creameries and cheese factories for the purpose of dividend-making be certified as to its accuracy and that all operators of the Babcock test, if used for this purpose, be licensed after proving their ability. The execution of the law was vested in the superintendent of the dairy school of the University; the details connected therewith have been carried out by the writers.

The text of the law is as follows:

No. 81.

AN ACT FOR THE PROTECTION OF DAIRYMEN, RELATING TO TESTING MILK AND CREAM

It is hereby enacted by the General Assembly of the State of Vermont:

Section 1. All bottles, pipettes or other measuring glasses used by any person, firm or corporation, or their agents or employees, at any creamery, butter factory, cheese factory, or condensed milk factory, or elsewhere in this State, in determining by the Babcock test, or by any other test, the value of milk or cream received from different persons or parties at such creameries or factories, shall, before such use, be tested for accuracy of measurement and for accuracy of the per cent. scale marked thereon. It shall be the duty of the superintendent of the dairy school of the University of Vermont and State Agricultural College to designate some competent person to test the accuracy of such bottles, pipettes or other measuring glasses. The person thus designated shall so mark such bottles, pipettes or other measuring glasses as are found correct in marks or characters which cannot be erased, which marks or characters shall stand as proof that they have been so tested; and no incorrect bottles, pipettes or other glasses shall be thus marked. The superintendent of the dairy school shall receive for such services the actual cost incurred and no more, the same to be paid by the persons or corporations for whom it is done.

Section 2. Each and every person who, either for himself or in the employ of any other person, firm or corporation, manipulates the Babcock test, or any other test, whether mechanical or chemical, for the purpose of measuring the contents of the butter fat in milk or cream as a basis for apportioning the value of such milk or cream, or the butter or cheese made from the same, shall secure a certificate from the superintendent of the dairy school of the University of Vermont and State Agricultural College that he or she is competent and well qualified to perform such work. The rules and regulations in the application for such certificate and in the granting of the same shall be such as the superintendent of the school may arrange. The fee for issuing such certificate shall in no case exceed one dollar, the same to be paid by the applicant to the superintendent of the dairy school and be used by the superintendent in meeting the expenses incurred under this section.

Section 3. Any person or persons violating any of the provisions of this act, shall, on conviction in a court of competent jurisdiction be fined not more than twenty-five dollars for the first offence, and not more than fifty dollars for each subsequent offence. It shall be the duty of every sheriff, deputy sheriff and constable to institute complaint against any person or persons violating any of the provisions of this act, and, on conviction, one-half of the fines shall go to the complainant and the balance to the State.

Approved November 19, 1898.

The essential points of the law may be concisely stated as follows:

Section 1 provides that all Babcock glassware *used in dividend making* at creameries, cheese factories, etc., shall be tested as to accuracy by some competent person, the same, when tested and found accurate, to be indelibly marked as proof of correctness, the cost of such testing and marking to be paid by the parties for whom the work is done.

Section 2 provides that all operators of the Babcock test *used in dividend making* at creameries, cheese factories, etc., shall secure certificates setting forth their ability to analyze milk accurately, the same to be issued on proof of such ability and under such rules and regulations as may be prescribed, the fee for the certificate not to exceed one dollar.

Section 3 is a penal section.

Glassware.—There have been tested within the past nine months 12,755 pieces of glassware, including 11,058 bottles, 1,168 pipettes and 529 acid measures. A considerable number of incorrect pipettes and acid measures have been regraduated and forwarded. 199 incorrect bottles (1.8%) have been found. The effect of as well as the necessity for the law is well shown by the comparison of the percentage of accuracy of the apparatus in use and that brought into the state after the passage of the law.

Old	4427 bottles	145 bad	3.3 % bad
New	6631 "	54 "	0.8 % "

The extent of the inaccuracy of the individual bottle has been on the whole less with the new than with the old apparatus. Correct apparatus, certified by this station, bears the etched letters VT EX ST on the neck of the bottle, pipette or measure; incorrect bottles are indelibly etched BAD.

Certified apparatus is kept on hand at all times by the larger Vermont dairy supply houses. The station does not carry Babcock glassware for sale.

Operators.—There have been 286 applications for license. Of these 252 have been granted, 33 refused because of inaccurate testing and one case is now pending. Something over 10 per cent of those desiring to test milk at creameries did not sufficiently understand the process to obtain correct results even under conditions when, if ever, accuracy would have been striven for. In the absence of the law these parties would have been today testing the patrons' milk at several creameries. Several cases have developed where incorrect results were due to faulty or worn centrifugal machines. In all these cases a second examination with good apparatus has resulted in licensing the applicants.

The regulations governing the issuance of licenses will be furnished at any time on application to the station.

MISCELLANEOUS ANALYSES

Section 263 of the Vermont Statutes requires the station to analyze without charge miscellaneous materials of an agricultural nature for the residents of the state. Many hundreds of analyses made have but a transitory interest; such as seem worth a permanent record are printed yearly under this head.

I. DRINKING WATER

Eighteen samples of drinking water were analyzed prior to January 1. Four of these were spring water, twelve well water and two brook water; and 0, 7 and 2 of these respectively were deemed impure or doubtful. In the past six years 249 samples have been analyzed and the following proportions of unsafe water found: spring, 22 per cent.; well, 50 per cent.; pond, etc., 42 per cent. It is but fair to say that in some cases the accuracy and cleanliness of sample-taking were open to question.

The station does not now analyze water samples. In accordance with Act No. 115 of the session of 1898 this work devolves upon the state board of health. Correspondence concerning water analyses should be addressed to Dr. Jo H. Linsley, director state board of health laboratory, Burlington, Vt.

	SOURCE OF SAMPLE	Parts per million		Grains per gallon			
		Free ammonia	Albuminoid ammonia	Chlorin	Total solids	Fixed solids	Volatile solids
Well	F. D. Corliss, St. Albans	0.01	0.12	0.3	17.5	15.2	2.3
Well	" " "	0.03	0.09	0.9	21.9	21.7	0.2
Spring	H. M. King, Woodstock	0.01	0.04	0.3	9.5	8.1	1.4
*Well	W. S. Ingalls, Greensboro	0.08	0.12	0.7	20.0	17.9	2.1
*Well	Dr. J. W. Sheehan, Winooski	0.06	0.23	1.5	6.7	1.4	5.3
Well	F. C. Wilkins, Williston	0.02	0.09	3.7	29.4	27.5	1.8
*Well	Dr. H. A. Crandall, Burlington	0.01	0.21	1.3	23.8	18.7	5.1
*Brook	C. C. Bogle, White River Junction	0.14	0.06	0.2	5.2	3.8	1.4
Spring	Geo. W. Guild, Waterbury Centre	0.03	0.07	0.3	6.8	5.3	1.5
*Brook	C. C. Bogle, White River Junction	0.05	0.07	0.3	5.1	3.7	1.4
*Well	Dr. W. H. Ranks, Shelburne	0.18	0.16	5.7	41.7	39.9	1.8
Well	Dr. F. S. Dillingham, Craftsbury	0.01	0.03	1.9	31.8	30.3	1.5
Well	" " "	0.01	0.05	1.8	23.8	20.6	3.2
Spring	S. J. Northrup, Shoreham	0.01	0.08	1.3	36.4	31.6	4.8
Spring	Miss C. de Nottbeck, Dorset	0.01	0.02	0.1	3.9	2.8	1.1
*Well	Dr. A. I. Miller, Brattleboro	0.07	0.12	1.2	22.2	10.2	11.9
†Artesian	E. B. Douglass, Shoreham	0.01	0.11	3.2	40.3	32.2	8.1
*Well	D. G. Donahue, Charlotte	0.18	0.29	0.1	18.8	15.6	3.1

*Impure and unfit for drinking purposes.

†Questionable.

II. SUGAR BEETS

The results of one year's experience of some score or more Vermont farmers in sugar beet growing were given in the last report.[1] The work was done in co-operation by the United States department of agriculture which furnished seed and this station which made the analyses and published results. The grade of beets was exceptionally high, but the season was inordinately wet and unfavorable.

Although not sanguine as to the likelihood of the industry proving successful in Vermont, the station aided the department during the past year to place seed for a second trial. Those sections of the state were selected which seemed for climatic and topographical reasons most likely to prove adapted to sugar beet growing. Hence most of the seed was sown in the Champlain and Connecticut river valleys. The season was on the whole favorable. Analyses were made at Washington and are kindly placed at our disposal. The following table shows maxima, minima and averages for each county.

1 Vt. Sta. Rpt. 11, pp. 177-180, (1898).

COUNTY	Number of samples	SUGAR IN BEETS			PURITY		
		Maximum	Minimum	Average	Maximum	Minimum	Average
Addison	11	14.3	10.6	12.4	83.5	72.1	79.2
Bennington	2	15.7	13.7	14.7	89.2	82.7	86.0
Chittenden	12	14.8	10.8	13.4	89.7	76.0	83.2
Franklin	11	15.3	12.4	13.7	91.0	79 8	86.0
Grand Isle	2	16.3	15.8	16.1	91.2	84.7	88.0
Lamoille	3	14.4	12.5	13.8	89.3	77.1	84.3
Orange	1			13.7			87.8
Orleans	3	13.0	11.3	12 1	82.0	77.7	80.2
Rutland	8	14.2	11.4	13.2	86.8	76.9	82.9
Washington	1			13.5			82.5
Windham	9	14.6	11.4	13.2	89.4	78.2	83.6
Windsor	2	12.4	11.2	11.8	80.2	78.1	79.2
1898	65	16.3	10.6	13.3	91.2	72.1	83.1
1897	32	19.6	11.2	16.3	91.1	72.0	84.2

The average beet last year weighed 17 ounces, this year 20 ounces. The second year's growth contained less sugar than the first. Probably the thinner stand caused by the wet weather of 1897 affected quality favorably.

A good grade of sugar beet may be grown in Vermont. This is not all that is needed, however, to make the manufacture of sugar feasible. The limitations to success in this state are restricted area, a short growing season and early winters. Hence it will be difficult, if not impossible, to establish the industry here, since in states further south and west such conditions do not prevail.

III. INSECTICIDES, ETC

The following preparations used for the purpose named have been analysed.

	Paris green	Green arsenite	Laurel green	Bug death	Herbicide
Moisture	0.80	1.55	5.25	0.10	65.85
Organic and volatile matter	----	----	7.65	----	----
Ferric and aluminic oxides	----	----	25.50	8.40	----
Calcium oxide	----	----	14.80	----	----
Copper oxide	34.40	34.00	18.20	----	----
Arsenious acid	55.48	59.79	2.05	----	20.45
Lead oxide	----	----	----	10.75	----
Zinc oxide	----	----	----	74.00	----
Insoluble matter (in water)	----	----	74.13	----	----
" " (in acid)	----	----	0.75	2.50	----

The difference between "green arsenite" and ordinary paris green seemed to be one of name only.

"Laurel green," a manufacturing by-product as sold in 1898[1] consisted mainly of calcium carbonate and of copper, iron and aluminum oxides. It contained but 2 per cent of arsenic.

"Bug death" was found to be roughly three fourths zinc oxide, one eighth lead oxide and one eighth iron and alumina oxides and sand.

1 It is claimed by the manufacturers to be notably richer in arsenic this year (1899).

The "herbicide" proved to be a concentrated solution of some alkaline arsenite, probably sodium arsenite.

For the results of the practical application of these materials the reader is referred to the report of the botanist on pages 154–155 of this volume.

IV. FERTILIZERS AND FERTILIZING MATERIALS

Several analyses of fertilizers, mostly home mixtures, have been made with results as given below. The practicability of this method of getting plant food has been abundantly shown in previous publications[1] and need not be further discussed.

HOME MIXTURES, ETC.

FROM	Nitrogen	Soluble phosphoric acid	Reverted phosphoric acid	Insoluble phosphoric acid	Total phosphoric acid	Available phosphoric acid	Potash
F. P. Bliss, Corinth	2.03	5.76	1.42	0.90	8.08	7.18	1.93
U. Colburn, Vershire	3.23	5.90	7.82	4.65	18.37	13.72	3.55
L. J. Sanderson, Highgate	2.44	6.86	1.84	1.00	9.70	8.70	3.41
F. P. Bliss, Corinth	2.58	10.43	2.13	0.14	12.70	12.56	2.97
J. O. Sanford, Stamford	2.03	9.48	2.25	0.08	11.81	11.73	12.90
F. Adams & Co., Bellows Falls	2.52	traces	10.93	10.13	21.06	10.93	2.89
Experiment Farm, Burlington	2.50	-- --	-- --	4.55	5.38	0.83	8.78
" " "	2.65	-- --	-- --	5.80	12.12	6.32	6.50
H. S. Brigham, St. Albans	3.12	-- --	-- --	1.32	7.53	6.21	7.34
H. E. Kelley, Bradford	1.12	-- --	-- --	2.75	10.59	7.84	3.36
A. M Vaughan, Woodstock	3.68	-- --	-- --	0.58	10.59	10.01	5.50
John W. Fowler, East Montpelier	1.48	-- --	-- --	3.11	8.99	5.88	11.74
" " "	1.44	-- --	-- --	3.84	10.19	6.35	7.56
L. J. Sanderson, Highgate	1.78	-- --	-- --	0.80	9.12	8.32	7.72
" "	2.46	-- --	-- --	1.12	9.56	8.44	5.12
E. O. Ferguson, Bristol	1.26	-- --	-- --	1.87	10.81	8.94	4.00
" "	1.09	-- --	-- --	1.06	9.31	8.25	4.04
F. Eaton, Corinth	2.42	-- --	-- --	2.22	12.76	10.54	2.38

ASHES

Ashes are quite largely bought in Vermont, particularly in the lower Connecticut valley. The analyses of 28 samples are given in the following table:

1 Vt. Sta. Buls. 47, 65, 71.

FROM	Soluble potash	Insoluble potash	Total potash	Total phosphoric acid	Calcium oxide	Insoluble matter
A. A. Dunklee, South Vernon	3.72	1.05	4.77	1.50	24.49	11.46
A. A. Dunklee, South Vernon	5.98	0.82	6.80	3.41	21.63	15.42
A. A. Dunklee, South Vernon	4.88	1.36	6.24	1.53	29.40	12.93
A. A. Dunklee, South Vernon	1.11	0.25	1.36	0.61	40.04	4.65
E. H. Ackley, Vernon	4.25	0.17	4.42	1.43	25.13	11.02
H. F. Bond, Westminster	5.02	2.34	7.36	2.23	19.92	19.87
H. F. Bond, Westminster	5.17	1.53	6.70	1.37	28.13	8.18
T. L. Johnson, Vernon	5.13	2.16	7.29	1.96	30.40	12.10
LeG. B. Cannon, Burlington	5.04	0.78	5.82	1.47	29.21	8.64
E. H. Fellows, South Lunenburgh	2.02	1.93	3.95	2.41	.. ..	15.35
A. M. Vaughan, Woodstock	4.77	1.39	6.16	2.11	45.40	11.55
A. M. Vaughan, Woodstock	5.51	0.66	6.17	1.90	37.70	6.10
L. W. English, Prosper	3.24	0.42	3.66	1.06	36.80	6.20
L. W. English, Prosper	9.76	0.29	10.05	1.72	55.80	4.63
A. M. Vaughan, Woodstock	7.76	0.88	8.64	1.91	47.60	7.15
H. A. Stockwell, Montpelier	4.51	0.39	4.90	1.40	33.35	7.93
H. A. Stockwell, Montpelier	3.63	1.72	5.35	1.30	33.90	6.70
A. M. Vaughan, Woodstock	7.12	1.64	8.76	2.04	38.64	9.90
A. M Vaughan, Woodstock	3.92	1.55	5.47	1.31	28.64	19.43
Experiment Farm, Burlington	6.34	1.63	7.97	1.59	34.92	16.75
E. O. Lee, Vernon	5.10	0.96	6.06	1.33	34.08	11.90
G. R. Maxham, Woodstock	5.04	1.48	6.52	1.28	39.32	8.25
T. L. Johnson, Dummer	4.82	1.50	6.32	1.30	40.04	11.70
H. F. Bond, Westminster	5.18	1.34	6.52	2.19	44.32	10.98
L. B. and F. Howe, Jericho	4.90	1.00	5.90	1.53	43.32	9.38
J. C. Wilder, New Haven	3.52	0.42	3.94	1.76	54.29	2.43
A. A. Dunklee, South Vernon	3.26	0.96	4.22	1.79	28.34	16.44
J. O. Sanford, Stamford	1.79	0.26	2.05	trace	56.20	4.93

The samples from New Haven and Stamford are limekiln ashes. The former is remarkably rich in potash for this class of material.

Twenty-six samples, said to be unleached, varied from 3.24 to 9.76% soluble potash, 3.66 to 10.05% total potash 1.06 to 3.41% total phosphoric acid, 19.92 to 55.80% lime and averaged 5.27, 6.05, 1.68, 34.82 percents respectively in the same ingredients.

Considered as a source of potash only they are expensive goods at ruling prices. It should be remembered, however, that the good results often obtained by their use are quite as apt to be due to their mechanical effect upon the soil or to their lime content, as to the potash they contain.

If 4½ cents a pound is allowed for soluble potash and for phosphoric acid in average ashes, costing $10 a ton delivered—which is not far from the average price throughout Vermont—it makes the lime cost 54 cents a hundred, which is quite an advance on the price for lime in Vermont markets. Hence it may be fairly questioned whether at ruling prices average ashes are as cheap as sources of potash, phosphoric acid and lime as are muriate of potash, acid phosphate and lime.

MUCK AND MISCELLANY

MATERIAL	FROM	IN ORIGINAL SUBSTANCE						IN DRY MATTER		
		Water	Ash	Organic and volatile	Nitrogen	Phosphoric acid	Potash	Ash	Organic and volatile	Nitrogen
Muck	L. W. Barton, Ludlow	8.83	2.53	88.64	1.32	....	....	2.77	97.23	1.45
"	Geo. Alger, Underhill	83.76	1.96	14.28	0.33	....	....	12.07	87.93	2.03
"	B. Lane, Newport	78.88	2.56	18.56	0.21	....	....	12.11	87 89	1.01
"	L. W. Barton, Ludlow	4.73	24.67	70.60	0.70	....	....	25.90	74.10	0.73
"	" " "	3.78	71.64	24.58	0.63	....	....	74.46	25.54	0.66
"	L. H. Sowles, Alburgh	82.80	3.94	13.26	0.29	....	....	22.92	77.08	1.69
"	F. A. Strong, Morrisville	55.51	15.75	28.74	0.64	....	....	35.40	64.60	1.44
Waste	W. H. H. Slack & Bro., Springfield	4.68	8.20	87.12	1.51	0.08	0.31	....	....	....
Cotton waste	W. P. Woodruff, S. Burlington	2.90	23.00	74.10	1.56	0.59	1.29	....	....	....
Prepared manure	R. H. Gale, Stowe	3.25	76.46	20.29	0.35	0.38	0.46	....	....	....

The well-known wide variation in the plant food content of muck is shown in the table. The first sample of waste abso rbed 69 per cent of its weight of water and might be used to advantage as an absorbent. The so-called "prepared manure" seems to have been "prepared" by mixing about three pounds of soil with one pound of manure. It contains less plant food than does average barn yard manure.

REPORT OF THE BOTANISTS

L. R. JONES AND W. A. ORTON

Most of the time in this department has been given to the study of plant diseases and their prevention. The topics in these and other lines in which the work has reached a stage to justify publication are indicated below.

Three additional subjects have received considerable attention, namely, a bacterial rot of carrots and other vegetables, the agricultural grasses and the phenemena of maple sap pressure and flow. It is not deemed expedient to discuss these studies in their present state of incompletion.

The subjects which are discussed are placed in following order:

Potato diseases and their remedies.

I. Potato diseases as they occurred in 1898.
II. Results of spraying potatoes in 1898.
III. Studies on the time and rate of development of the potato tuber.

Apple diseases and their remedies.

I. Spraying for the prevention of the apple scab.
II. The brown spot disease of apples.

A second partial list of the parasitic fungi of Vermont.

Killing weeds with chemicals.

POTATO DISEASES AND THEIR REMEDIES

I. POTATO DISEASES AS THEY OCCURRED IN 1898

The season was more favorable for potatoes than that of 1897, but the yields at Burlington were not large even with the best locations and culture. This was chiefly due to a period of drought in midsummer, there being but little rainfall between the middle of July and the middle of August. As a result practically all potatoes on light soils died during this period with the characteristic symptoms of tip-burn, while those more favorably situated suffered severely. The general appearance of tip-burn in such potato fields during the latter part of July closely following the attacks of the main brood of the flea beetles again emphasizes the close relationship which has been observed heretofore between the injuries of this insect and the "burning" of the foliage. The extent of the damage done by the flea beetle, especially in dry seasons, is generally underestimated.

The plants sprayed with bordeaux mixture were relatively exempt from the flea beetle attacks and also showed comparatively little tip-burn.

There was very little of either of the fungus diseases, the early and the late blights, (*Alternaria Solani* and *Phytophthora infestans*) upon the experiment station fields, or elsewhere in the vicinity of Burlington. Considerable damage from the late blight and the rot were, however, observed at several points in the interior of the state and reports indicate that where the weather was sufficiently moist there was the usual loss from this disease.

There was evidence of arsenical poisoning in many fields especially during July.

II. RESULTS OF SPRAYING POTATOES IN 1898

Experiments were planned in continuation of those of former years to determine the relative values of various forms of bordeaux mixture for use in spraying potatoes. Trial was made also of certain articles placed upon the market as combined fungicides and insecticides. Inasmuch as there was practically no development of fungus diseases upon any of our plots the trial of these compounds was of little significance, so far as concerns their fungicidal values. The results showed rather the value of the different preparations in protecting the plants from insect ravages chiefly those of the flea beetle and in preventing the death of the foliage from tip-burn, a trouble which as already stated is closely associated with insect injuries. In addition to its protection against insects and fungi the bordeaux mixture apparently so increased the general vigor of the foliage as to lessen the damage from tip-burn.

The forms of bordeaux mixture under trial were:

1. Standard bordeaux mixture.—1½ pounds copper sulphate, 1 pound lime, 10 gallons water. The lime and sulphate solution were each diluted with one-half the total amount of water, the latter then poured into the former and the mixture thoroughly agitated; freshly made as applied.

2. Improperly made bordeaux mixture.—This mixture contained the same proportions of lime and copper sulphate as did the standard but the method of combining them was different. The *concentrated* lime water (1 pound lime in 1 gallon water) was added to *concentrated* sulphate solution (1 pound sulphate in 1 gallon water), and this mixture stirred and then diluted. It has been shown [1] that a mixture so made is distinctly inferior in its mechanical properties and probably so in its chemical composition to one properly made, yet most of the directions for preparing this mixture given in the popular press and many of those in experiment station literature would, if followed, result in this inferior kind of a preparation.

3. Commercial bordeaux mixture.—There is a demand for a commercial form of bordeaux mixture which is supplied in a legitimate manner by man-

1 Vt. Sta. Rpt. 9, p. 88 (1895).

ufacturers who have placed upon the market a concentrated mixture in sealed packages to be diluted for use. These concentrated commercial mixtures must in all cases be made in substantially the manner cited under 2, above; and since the mechanical properties of bordeaux mixture deteriorate upon standing, it seems beyond question that any such concentrated mixtures must be distinctly inferior to that which is freshly prepared and properly made. Wishing, however, to determine the facts by actual test rather than to rely upon theoretical considerations alone, the "Lion Brand" of bordeaux mixture was included in the series. This was diluted according to directions and the same quantity of this diluted mixture was applied as of the other bordeaux mixtures.

The following results are averages deduced from a series of 20 plots.

COMPARATIVE TESTS OF VARIOUS FORMS OF BORDEAUX MIXTURE

Fungicide used	Dates of applications	Average yields in bushels per acre	
		marketable tubers	small tubers
Standard bordeaux mixture, 3 times	July 21 Aug. 9 Sept. 9	239	28
Improperly made bordeaux mixture, 3 times	July 21 Aug. 9 Sept. 9	230	28
Standard bordeaux mixt., 2 times	Aug. 9 Sept. 9	186	20
Commercial bord. mixt., 2 times	Aug. 9 Sept. 9	159	34
Check, no fungicide	Paris-green enough to destroy Colorado potato beetles.	112	42

DISCUSSION OF THESE RESULTS

The more important conclusions to be drawn from these experiments in our judgment are as follows:

1. *Standard bordeaux mixture.—Three applications* more than doubled the yield where properly used; and this in the absence of fungus diseases.

Two applications were remarkably inferior to the three. This was because the flea beetle and drought combined did the greatest damage before August 9th, the date of the first sprayings on these plots. Nearly one half of the benefit from the use of the mixture was thus lost. On the other hand under the climatic conditions of 1898, two applications made say July 21 and August 10th would probably have insured nearly as large gains as did the three noted above. In other words to insure the best protection the spraying should be given so early as to be distinctly in advance of the main

brood of the flea beetles which appeared about July 25 in 1898. Whether one or two later applications are given should depend upon various conditions including those of variety, weather and of the occurrence of diseases.

2. Improperly made bordeaux mixture proved somewhat inferior to the standard as judged by yield. It was, moreover, more difficult to apply owing to the coarser character of the precipitate. This condition necessitated more frequent agitation, made uniformity in application very difficult and led to more trouble from the clogging of the nozzles. It also appeared to be less adhesive to the foliage than did the properly made mixture.

3. Commercial bordeaux mixture proved to be distinctly inferior to the standard bordeaux mixture. It was open to the practical objections just urged against the improperly made mixture but to a much greater degree. Uniform application was practically impossible as the precipitate was coarse grained and settled very rapidly. It also troubled a great deal by clogging the nozzles. The price of this "Lion Brand" is $1.50 for the can which is to be diluted to 50 gallons. This makes the price 3 cents a gallon for the diluted mixture, whereas the chemicals required for home-preparation of the standard mixture cost one cent or less a gallon. The commercial mixture cannot therefore be considered a successful substitute for the home-made mixture except for small operations in gardens and green-houses. In these its use can be defended solely on the ground of its convenience.

BUG DEATH AND LAUREL GREEN [1]

Two commercial powders, bug death and laurel green, are being offered in the Vermont market as substitutes for paris green and bordeaux mixture for use on potatoes. The former is claimed to be non-poisonous and both are said to be preventives of insects and blights. As numerous inquiries relative to these powders were received we decided to test their merits, as compared with bordeaux mixture. The question of first importance in our mind in planning these experiments was as to whether or not these powders had fungicidal value. The trial rows were therefore treated alike with paris green until the use of bordeaux mixture was begun on the adjacent plots. Alternate rows were thereafter treated with bordeaux mixture, bug death and laurel green, check rows being treated with enough paris green to keep off the Colorado potato beetles.

In order to give these compounds the fairest and fullest opportunity to prove their merits the quantity of each used was far in excess of that recommended on the packages. Approximately 45 pounds per acre was applied at each date, which is many times as much as would usually be advised. Three applications were made at the dates when bordeaux mixture was used on the other plots, viz: July 21, August 9, September 6. The compounds are both in the form of fine powders and are most conveniently

1 See analyses in report of chemists, p. 147.

applied in the dry form. They were so used upon part of the plots; upon others they were mixed with water and applied with the spray pump.

As stated above the object of the trial was primarily to determine if these compounds had value as fungicides. In the absence of fungus diseases this was not accomplished. The vines were, however, well protected against the Colorado beetle by both substances and, moreover, used in this excessive amount, both alike served to check the attacks of the flea beetle to a very considerable degree. The benefits accruing were therefore appreciably greater than came from the usual applications of paris green. On the other hand the plots where these powders were applied were less adequately protected against insects and showed more tip-burn than did these sprayed at the same dates with bordeaux-paris-green mixture.

These facts were best shown by the relative condition of the foliage of the various plots during the latter part of August and first part of September. They are also indicated by the following tabular summary of the yields of marketable tubers in bushels to the acre:

Bordeaux mixture, 3 applications	239
Bug death, 3 applications each of 45 lbs. per acre, applied dry	209
Same, but applied with water	219
Laurel green, 3 applications each of 45 lbs. per acre, applied dry	174
Same, but applied with water	167
Chock	112

Conclusions.—The results showed that both laurel green and bug death have value as preventives of insect injuries to potatoes. It is not fair to conclude from our experiments what that value is as compared with paris green since we used amounts of these far in excess of those recommended or practicable in regular commercial conditions. Even with these extremely liberal applications they were inferior to bordeaux mixture. In both cases slightly better results were obtained by applying them in water, probably because of more uniform application and better adhesion to foliage. Their value as fungicides was left undetermined.

III. STUDIES ON THE TIME AND RATE OF DEVELOPMENT OF THE POTATO TUBER

Studies along this line were made in 1893[1] and the results were of so much interest and value in judging of the importance of spraying that we have desired to repeat the observations. For this purpose some seventy-five rows of potatoes were staked out across one end of our field. One half of these were White Stars, the other half were Delawares. All were planted May 16, on rather heavy clay soil. The use of paris green in the earlier part of the summer and three applications of bordeaux mixture in the lat-

1 Vt. Sta. Bul. 40, p. 26 (1893).

ter part kept these vines in fairly healthy condition in spite of the severe drought and insect attacks of July and August. Digging was begun in August 4, every ninth row being dug on that date. Ten days later a similar digging was made and so on at intervals of as nearly ten days as weather would permit, records of yields being kept. The two varieties developed so similarly that the results from them are averaged together.

The yields at each of the dates of digging are summarized below in terms of bushels to the acre. For purposes of comparison the results of the former year are also included in this table.

White Star, planted May 20, 1893

	Total yield	Yield of marketable size
Aug. 2	58	----
" 12	115	----
" 22	230	163
Sept. 1	304	234
" 12	356	303
" 22	379	353

White Star and Delaware, planted May 16, 1898

	Total yield	Yield of marketable size
Aug. 4	92	65
" 15	99	76
" 24	116	88
Sept. 3	153	130
" 13	172	152
" 26	197	181
Oct. 6	226	209

Some conclusions may profitably be drawn from the above table.

It is to be noted in the first place that there was quite uniformly good growing weather throughout the summer of 1893, whereas there was a severe drought during July and August, 1898, hence the results were more representative in 1893 than in 1898.

In both seasons a considerable portion of the ultimate yield of marketable tubers was formed after September 1st. In 1893 only one-half of the total yield of marketable tubers was formed on August 24th, in 1893 this point was reached August 28. In view of this fact it is significant to recall the condition of the average *unsprayed* potato fields during the last week of August. In our own plots in 1898 the unsprayed vines were nearly all dead before August 20th, and the small yield on these unprotected plots (112 bushels an acre on the unsprayed plots as contrasted with 239 on those sprayed) is the natural consequence. We are lead to repeat with emphasis the statement made in the report of 1893 that *the potato crop of Vermont suffers far more each year than is generally realized from the premature death of the vines.*

APPLE DISEASES AND THEIR REMEDIES

I. SPRAYING FOR THE PREVENTION OF APPLE SCAB

Mr. A. H. Hill of Isle La Motte kindly continued during 1898 the experiments which were discussed in our last report.[1]

These experiments were planned by Mr. Hill with the advice of the writers and were designed to afford information as to the relative gains from

1 Vt. Sta. Rpt. 11, pp. 195-198 (1898).

a larger or smaller number of sprayings of apple trees with bordeaux mixture for the prevention of scab. Mr. Hill's large orchard of Fameuse trees is admirably adapted to the work. From the experimental standpoint it would have been desirable to use a larger block of trees in order to secure averages from duplicated results. The trees were, however, carefully selected and may be considered as showing practicable results.

The main body of Mr. Hill's orchard was sprayed five times. A block of five trees near the middle of the orchard was labeled for experimental spraying. One of these was sprayed twice, another three times, another four times, a fourth, like the body of the orchard, was sprayed five times and a fifth was given the same treatment with an additional application of paris green. In this spraying three different solutions were used as follows:

A. Paris green, 1 lb. in 200 gallons of water.

B. Copper sulphate, 1 lb. in 23 gallons water.

C. Bordeaux-paris-green mixture: 12-18 pounds copper sulphate, 8-12 pounds lime, 1 pound paris green, 200 gallons water.

The bordeaux mixtures were rather more dilute than is generally recommended by this experiment station, but Mr. Hill believes he has had more satisfactory results in practice from using dilute solutions and making proportionately more liberal applications. The stronger mixture (18 pounds sulphate, 12 pounds lime) was used in the first three applications, and the weaker one (12 pounds sulphate, 8 pounds lime) in the last two.

The dates and nature of the applications on the experimental trees were as follows:

Tree 1. Sprayed twice with A, June 4 and June 20.

Tree 2.[1] Sprayed 3 times; with B, April 25; with A on June 4 and 20.

Tree 3. Sprayed 4 times; with B, April 25; with C on May 13; with A on June 4 and 20.

Tree 4. Sprayed 5 times; with B, April 25; with C on May 13 and 28; with A on June 4 and 20.

Tree 5. Sprayed 6 times, the same as tree 4 with addition of C on June 15.

It will be observed that two extra applications of paris green were made during May and June, Mr. Hill judging that these were needed to destroy the forest tent-caterpillars which appeared in alarming numbers. The results obtained on tree 5 would ordinarily be insured without the two applications of A in June.

The results were as follows:

Tree	How sprayed	Condition of fruit					
		No. 1		No. 2		Cider apples	
1	Paris green twice	1	apple	2	pecks	3	pecks
2	" " " plus copper sulphate once	2½	pecks	7½	"	2	"
3	Same as tree 2 plus bordeaux-paris-green once	6	"	8	"	2	"
4	" " " " " " " " twice	7	"	4	"	1½	"
5	" " " " " " " " thrice	12	"	4	"	2	"

1 By mistake one side of this tree was partly sprayed with C May 13.

These results may be shown more clearly in two other ways, first by disregarding the actual yield of the trees and stating the relative yields of each grade in per cents of the total yield of that tree.

The other method is the statement of the actual value of the crop from each tree following the values of the different grades given by Mr. Hill, viz: No. 1, $3.00 a barrel; No. 2, $1.50 a barrel; and cider apples, $0.40 a barrel. These two methods are used in the following table:

Tree	How sprayed	Per cents of each grade			Value of crop
		No. 1	No. 2	Cider apples	
1	Paris green twice	?	40	60	$0.48
2	" " " plus copper sulphate once	21	62	17	1.69
3	Same as tree 2 plus bord. paris green once	57.5	50	12.5	2.57
4	" " " " " " " " twice	56	32	12	2.80
5	" " " " " " " " thrice	67	22	11	3.56

Some conclusions.—These results are in accord with all our former experiments and with the practical experience of Mr. Hill and many other orchardists that *one cannot afford to grow apples for market without properly spraying the trees.* The actual gain will depend upon varieties, seasons and other conditions, but intelligent spraying is an indispensable factor in the best success.

These results emphasize the importance of two conclusions which have been reached in former years.

1. The very great relative importance of spraying early in the season; the application of copper sulphate solution before the leaves open and bordeaux-paris green mixture before the blossoms open being especially important.

2. One or more, usually two, applications of the bordeaux-paris green mixture after the blossoms fall are required for the best protection of such susceptible varieties as the Fameuse.

The date of the printing of this report permits us to add the following notes on the experience in this same orchard in the summer of 1899. The forest tent-caterpillar threatened to invade the orchard in such numbers that it was deemed inadvisable to leave any trees unsprayed. The season has been an unusually dry one and the mixtures have clung to the foliage very persistently. Two sprayings have under these circumstances given adequate protection. These were made as follows:

1. Bordeaux-paris green mixture, just before the blossoms opened.
2. This same mixture again as soon as the blossoms fell.

A visit to this orchard in August 1899 showed it to be in remarkably healthy condition. There had been no trouble with forest tent-caterpillars or other insects although unsprayed orchards immediately adjoining had been stripped of practically every leaf. A half hour's search passing hundreds of Fameuse trees well loaded with fruit revealed scarcely a scabby apple. A very important point is brought out in the following statement by Mr. Hill in a recent letter: "I have made a thorough investigation of

the orchard. I find more scab on the one Fameuse apple tree which was left unsprayed in connection with the experiments of 1897 and 1898 than on all the rest of my Fameuse trees together. I found only 5 scabby apples in all the rest of the orchard, whereas there were a considerable number on the tree unsprayed in the two previous seasons." It is to be noted that this condition existed in spite of the fact that this tree was sprayed as thoroughly as were the others in 1899. The greater amount of scab on this tree must therefore be attributed to the fact that the fungus had not been suppressed during the preceding two seasons.

These conditions emphasize in a remarkable manner the gain that is assured from intelligent spraying and also the encouraging fact that the results are *cumulative* so that after an orchard has been thoroughly sprayed for several seasons as has Mr. Hill's, less spraying is required to hold the scab and other pests in check. They indicate also the importance of spraying every season.

II. THE BROWN SPOT OF THE APPLE

In the fifth annual report of this station[1] mention was made of the occurrence of a fruit spot of the Baldwin apple. Examinations at that time revealed an obscure fungus inhabiting the diseased tissues. Specimens were submitted to J. B. Ellis who reported that the fungus was probably the species called by de Schweinitz *Dothidea pomigena*. Subsequent examinations of herbarium material and literature have shown[2] that *Dothidea pomigena* Schw., is a quite different fungus from the one which occurred in these spots. We have never secured satisfactory fruiting specimens of the fungus in question, and so far as we know the species remains undetermined. Since it is undoubtedly a saprophyte this becomes a matter of less economic importance.

Re-examination of these brown spots has been made by us on various occasions since our earlier publication. In most cases, especially in the autumn and early winter, no fungus has been detected in the browned tissues, and it has therefore become evident to us that the spotting was not primarily a fungus disease.

The pressure of other work prevented a more careful study of the matter, however, until the past season. Specimens of Baldwin apples were then examined, beginning with the first evidences of their spotting in the

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1. Vt. Sta. Rpt. 5, p. 133 (1891).

2 Sturgis in Conn. Sta. Rpt. 21, p. 171 (1897) points out that de Schweinitz's description of *Dothidea pomigena* (*Phyllachora pomigena* (Schw.) Sacc.) agrees very well with the characters of the superficial fungus growth known as the sooty mould of the apple. Unfortunately de Schweinitz left no specimens of this fungus among his exsicatti. A careful comparison of the sooty mould with his description leaves no doubt in our mind as to the correctness of Sturgis' conclusion.

autumn before harvest. The spots in the early stage of their development were found to be covered with an unbroken epidermis and the diseased tissues were free from fungus invasion.

Careful search was also made for bacteria in the browned tissues of the spots and in the adjacent apparently normal tissues. This included both microscopic examinations and the transference with proper precautions of bits of the tissues to various culture media (bouillon, gelatin, agar and special media containing malic acid.)

In no case were bacteria found. There remained no doubt therefore in our minds that the spots were not due to the direct invasion of the tissues by fungi or bacteria.

Several facts of interest were observed, however, some of which had been noted also in previous seasons.

1. While the spotting was worse in case of Baldwins than with any other variety in Vermont, it was not confined to this variety. It was quite common on Northern Spies and was observed also on Greenings.

2. The spots were not uniformly distributed over the surface but were considerably more numerous toward the eye (apical portion) than toward the cavity of the fruit (basal portion.)

3. The spots were not confined to the surface but appeared at various depths in the flesh, the deeper ones often being overlaid by a half inch or more of sound flesh.

4. The spots were *associated in their distribution with that of the vascular bundles*, occurring at or near the ends of the veins which permeate the flesh of the fruit.

Having opportunity at this stage of the study to confer with the officers of the Division of vegetable physiology and pathology of the United States department of agriculture it was learned that Mr. M. B. Waite and Dr. E. F. Smith had made observations upon a similar spotting of apples which they were satisfied was a non-parasitic disease and which Dr. Smith considered identical with a dry spot disease described by Wortmann as occurring in Europe.

The examination of Wortmann's paper[1] leaves no doubt that the disease discussed by him under the name "Stippen" or "Stippich-werden" is identical with the brown spot of the Baldwin, although the Baldwin did not chance to be among the varieties included in his studies.

Wortmann's work has been recently critically reviewed and his conclusions reaffirmed and somewhat extended by Bschokke.[2] Numerous experiments were devised and conducted by Wortmann and others by Bsch-

1 Wortmann, Ueber die sogenannte, "Stippen" der Aepfel. Landw. Jahrb., 21, pp. 663-675 (1892).

2 Bschokke, Landw. Jahrb. d. Schweiz, 11, pp. 192, (1897). This author gives a very complete bibliography of the German literature of the disease.

BROWN SPOT OF THE BALDWIN APPLE

Spotted apple shown in the upper figure. Cross sections through the same fruit in the lower figures. That at the right was made near the apex or eye of the apple, that at the left near the base or cavity. Note the greater development of spots in the former.

(From photographs, natural size.)

okke in connection with their studies which satisfied them of the correctness of their conclusions.

As the season was far advanced before we had access to these papers, we have not repeated these experiments. It is of course desirable that this be done with other varieties and especially with the Baldwin. Meanwhile it seems worth while to summarize our present information regarding this spot disease, including Wortmann's and Bschokke's explanation of its causes.

SUMMARIZED DISCUSSION OF THE BROWN SPOT OF THE APPLE

Characters.—This disease usually appears superficially on the fruit as small sunken brown spots scattered over the surface of the apple, but more abundantly near the eye or apical portion. These spots may appear before maturity, but usually are seen only after the apples have lain in storage some time, and tend thereafter to increase in number and size. The spots usually vary in diameter from two to five millimeters (one-twelfth to one-fifth inch). The superficial spots usually lie immediately underneath the epidermis, which in the earlier stage of their development is unbroken. Upon cutting into such a spot it is found to consist of rather dry, dead and browned tissue, extending into the flesh for a distance about equal to its diameter. Similar areas of dead and brown tissue may occur scattered at various depths in the flesh nearly to the core. Most of the above facts are well illustrated in the accompanying figures. Examination shows the spots to be associated in their distribution with the occurrence of the vessels (vascular bundles) of the fruit.

This browned tissue may have a slightly bitter flavor in the older spots, but this bitterness is not constant and in no case in our observation is it very decided.

Occurrence.—The trouble is of widespread occurrence both in Europe and in America. It is worse on some kinds of apples than on others; and upon the same kind its occurrence varies with climatic or cultural conditions, and probably with those of storage. Wortmann states that large, sappy varities and specimens are most liable to spot.

The variety pre-eminently subject to it in the northeastern United States is the Baldwin. It has already been stated that it is of frequent occurrence on Northern Spy in Vermont and not rare on Greenings. Selby records the occurrence of the Baldwin spot in Ohio and also that of a brown spot on Northern Spy and other varieties.[1] Craig[2] reports it as occurring in the following varieties in Canada: Baldwin, Ben Davis, Fameuse, Golden Reinette, Golden Russet, Hurlbut, Lawver, Malinda, Northern Spy, Orange Winter, Patten Greening, Plumb Cider, Princess Louise, Rawle's Janet,

1 Ohio Sta. Bul. 79, p. 134-135, (1897).

2 Canada Exp. Farms, Rpt. 10, p. 172, (1896).

Canada Red, Romna, Salome, Seedling, Seek-no-further, Simbirsk No. 4, Silken Leaf, Talman, Winter Bough, Winter Rose.

Wortmann records the trouble as occurring in varying degrees upon numerous varieties in Europe as follows: Red Reinette, Golderling, Woltman's Reinette, Hawthornden, Winter Pearman, Landsburger Reinette, Stettin, Dantziger.

Damage.—The greatest damage is to the appearance of the fruit. The bitter flavor is rarely so prominent as to be serious.

Lamson[1] who has seen much of the trouble in Baldwins in New Hampshire says that the disfigurement of the fruit is often so great as to render an otherwise perfect apple a second. T. B. Wilson, a large apple grower of Hall's Corner, N. Y., writes us that these spots "are a great annoyance and cause quite a loss to the orchardists of western New York." Craig,[2] speaking of the conditions in Canada in 1896, states that while such apples are not rendered wholly unfit for use their appearance and salability were totally destroyed.

Cause.—Neither fungi nor bacteria are to be found in the earlier stages of the spot formation nor is there a constant occurrence of any such organism in the later stages. It is therefore a non-parasitic disease.

Wortman's observations and experiments lead him to conclude that the death of the cells in these spots is a result of the concentration of the sap following the loss of water. This water may be lost by direct transpiration in the case of the superficial cells, or in case of the deeper cells by excessive conduction of the water to the transpiring surface layers. The acidity of the concentrated sap is considered to be the direct cause of the injury, this injury being followed by the browning through oxydization.

Several factors may therefore enter into the problem of spot formation.

1. The amount and rapidity of transpiration. This is dependant upon the character of the epidermis, conditions of storage, etc. The fact is emphasized that *gradual* loss of sap is essential to the formation of typical spots. Thus a specimen of a variety which is subject to spot will shrivel without the appearance of spots if kept in a warm dry room. Wortmann suggests that in case of such very rapid loss of water the acid of the concentrated sap has insufficient time to act.

2. The kind and relative amount of substances in solution in the cell sap. The same degree of concentration of different solutions may not be equally injurious, hence the actual per cent of water lost in spotting and non-spotting varieties may not stand in a direct relation to their susceptibility to the disease.

3. The conductivity of the tissues of the fruit. The original loss of water must always occur at the surface. The death of these surface cells

1 N. H. Sta. Bul. 45, p. 46 (1897).

2 Canada Exp. Farms Rpt. 10, p. 171 (1896).

may ultimately follow unless this loss is made good by the conduction to them of water from the underlying tissues. In some varieties this conduction occurs more rapidly than in others. Wortmann found that in varieties subject to spot there was relatively slow water conduction.

Bschokke considers this relative rate of water conduction to be the most important factor in deciding the susceptibility of a given variety to the spot disease.

4. The specific resistance of the protoplasm of the cells to the injurious action of the concentrated sap. This is probably greater in some varieties than in others, and it may vary also with climatic and other cultural conditions.

Remedies.—Wortmann concludes that the spotting of susceptible varieties cannot be prevented entirely, but that, since trees which are improperly cared for produce fruit of less resistance toward unfavorable influences of every sort, proper attention to fertilization and general cultural conditions is called for. He believes that moist cloudy weather, which decreases starch formation, favors the disease and that in seasons where such weather predominates an excess of nitrogenous fertilizer is especially unfavorable. He recommends a dry sunny exposure and pruning so as to admit sunlight. On theoretical grounds he believes that storage in a moist atmosphere with uniformly low temperature will lessen the development of the spots. He also suggests the probable protection which would come from wrapping the apples separately in paper to check transpiration.

Bschokke revives a suggestion from the older literature that since apples which have lost a considerable moisture from their superficial tissues by *rapid* evaporation do not spot some treatment involving this method might be employed in bad cases. It is doubtful if this will commend itself in actual practice, although it has some theoretical interest.

Lamson finds that spraying Baldwins with bordeaux mixture—about as recommended for the scab fungus—reduces the amount of spotted fruit to a remarkable degree.

The following is a summary of his results :[1]

Prevention of brown spot of Baldwin by spraying with bordeaux mixture		Per cent of spotted fruit	
		Sprayed	Unsprayed
1895	Sprayed once before and twice after blossoming.....	3	55
1896	Sprayed once before and once after blossoming.....	10	68
	Sprayed once after blossoming.....	18	68
1898	Sprayed once before and twice after blossoming.....	22	52

These results are certainly very striking. In view of the above explanations of the cause of this disease the question of why spraying should check the tendency to spot becomes a matter of a considerable practical as well as theoretical interest.

1 N. H. Exp. Sta. Buls. 45, (1897) and 65 (1899).

In this connection it should also be observed that Craig reported[1] adversely to bordeaux mixture as a remedy for this spot, but as his conclusions were based on general observations rather than exact experiments they cannot be weighed fairly against Lamson's conclusions.

A SECOND PARTIAL LIST OF THE PARISITIC FUNGI OF VERMONT

INTRODUCTION

The following list of fungi has been prepared by W. A. Orton as a continuation of that published in the last report, pages 201–217. The previous list included the Phycomycetes, Erysipheæ, Ustilagineæ and Uredineæ. The present list includes some corrections and additions to these groups and more or less complete lists of the Exoasci, Pyrenomycetes and Fungi Imperfecti.

While this list comprises primarily the parasitic fungi, there are several species which are undoubted saprophytes and many others partially so. Since there is in nature no sharp line of distinction between saprophytes and parasites, the attempt more completely to separate them here would have lessened the scientific value of the list and added little to its usefulness in other ways.

The nomenclature follows in general Saccardo's Sylloge Fungorum. In the Pyrenomycetes Ellis and Everhart's North American Pyrenomycetes has been followed. The common names of the host plants have been given so far as possible. The place and date of collection are given in every case. The name of the collector is indicated by an initial. C. stands for H. I. Collins; G. for A. J. Grout; H. for T. E. Hazen; J. for L. R. Jones and O. for W. A. Orton. The number following the initial refers to the number of the specimen in the Vermont experiment station herbarium on which the citation is based. Unless otherwise stated it will be understood that the fungus occurs on the leaves of the host.

We are greatly indebted for assistance to the Division of vegetable physiology and pathology of the United States department of agriculture, where many doubtful specimens were taken for identification; to Dr. J. C. Arthur of Purdue university, Indiana, who has kindly looked over some of the Uredineæ; to Dr. E. A. Burt of Middlebury, who has identified many of the Pyrenomycetes and Discomycetes; to Dr. L. M. Underwood and others of Columbia university; and to the various collectors who have added to the list.

CORRECTION TO THE FIRST LIST

P. 17, omit Puccinia Gentianæ (Strauss,) Link.

Omit, under Puccinia graminis, on Festuca pratensis and on Poa pratensis.

1 Canada Exp. Farms, Rpt. 10, p. 171 (1896).

ADDITIONAL HOSTS FOR SPECIES PREVIOUSLY REPORTED

PHYCOMYCETEÆ

CYSTOPUS CANDIDUS (Pers.) Lev.

On Brassica Rapa, cultivated turnip. Burl., Sept. 1898; O. 1939.

ERYSIPHEÆ

ERYSIPHE CICHORACEARUM DC.

On Achillea Millefolium, Yarrow. Burl., Sept. 1898; O. 1994.

On Dahlia variabilis, Dahlia. Burl., Sept. 1898; O. 1989.

On Helianthus multiflorus, Double sunflower. Burl., Sept. 1898; O. 1993.

ERYSIPHE COMMUNIS (Wallr.) Fr.

On Clematis sp., cult. Burl., Sept. 1898; O. 1992.

MICROSPHÆRA ALNI (DC.) Wint.

On Viburnum Lentago, Sheepberry. Fairfax, Oct. 1898; O. 1987.

MICROSPHÆRA RAVENELII Berk.

On Lathyrus odoratus, Sweet pea. Burl., Sept. 1898; O. 1991.

PHYLLACTINIA SUFFULTA (Reb.) Sacc.

On Betula papyrifera, Paper birch. Burl., Oct. 1898; O. 2228.

UNCINULA SALICIS (DC.) Wint.

On Salix nigra, Black willow. Burl., Sept. 1898; O. 1984.

UREDINEÆ

ÆCIDIUM ASTERUM Schw.

On Solidago rugosa, Goldenrod. Burl., May, 1896; J. 2085.

GYMNOSPORANGIUM GLOBOSUM Farl.

I. On Pyrus Malus, Apple. Burl., Sept. 1898; O. 2086.

GYMNOSPORANGIUM MACROPUS Link.

III. On Juniperus Virginiana, Juniper. Burl., May, 1899; O. 2901.

MELAMPSORA FARINOSA (Pers.) Schroet.

On Salix caprea. Burl., Sept. 1898; O. 2086.

PUCCINIA POLYGONI Pers.

II, III. On Polygonum convolvulus, Bind-weed. Isle La Motte, Oct. 1898; O. 2073.

PUCCINIA TANACETI DC.

III. On Helianthus tuberosus, Jerusalem artichoke. Burl., Nov. 1898; O. 2072.

ADDITIONAL SPECIES NOT PREVIOUSLY LISTED

PHYCOMYCETEÆ

SYNCHYTRIUM ANEMONES (DC.) Wor.

On Anemone nemorosa. Burl., Aug. 1892; J. 1944.

On Anemone Virginiana. Burl., Aug. 1897; O. 1997.

EMPUSA MUSCÆ (Fr.) Cohn.

On Musca domestica, House-fly. Burl., Sept. 1892; J. 2226.

USTILAGINEÆ

DOASSANSIA SAGITTARIÆ (West.) Fisch.

On Sagittaria sp., Arrowhead. Burl., Sept. 1898; O. 2783.

UREDINEÆ

ÆCIDIUM PUNCTATUM Pers.

On Anemone nemorosa. Burl., May, 1891; J. 1998.

PUCCINIA RUBIGO-VERA (DC.) Wint.

II. On Festuca pratensis, Fescue. Burl., June, 1898; White, 1822.

II. On Poa pratensis, June-grass. Burl., July, 1898; H. 1823.

UROMYCES GENTIANÆ Arthur.

On Gentiana quinqueflora, Gentian, Manchester, G. 2838.

GYMNOASCI

EXOASCUS ALNI-INCANAE Kuehn (*Taphrina Alni-incanae* (Kühn.) Magn.)

On catkins of Alnus incana, Alder. Burl., July, 1893; J. 1948. Johnson, Sept. 1893; G. 1947. Beaver, Aug. 1897; O. 1946.

EXOASCUS CONFUSUS Atks. (*E. Pruni* Fckl.)

On young fruit of Prunus Virginiana, Choke-cherry. Burl., May, 1898; O. 1954.

EXOASCUS DEFORMANS (Berk.) Fckl. (*Taphrina deformans* (B.) Tul.)

On Prunus Persica, Peach. Grand Isle, June, 1895; J. 1958.

TAPHRINA CÆRULESCENS (D. & M.) Tul.

On Quercus rubra, Red oak. Burl., Oct. 1890; G. 1974.

TAPHRINA RHIZOPHORA Johans.

On ovaries of Populus monilifera, Cottonwood. Burl., May, 1897; J. 1977.

PYRENOMYCETEÆ

ASTERINA GAULTHERIAE Curt.

On Gaultheria procumbens, Wintergreen. Burl., May, 1890; J. 327.

ASTERINA PLANTAGINIS Ell.

On Plantago Rugellii, Plantain. Burl., Aug. 1897; O. 2994.

ASTERINA RUBICOLA E. & E.

On Rubus strigosus, Red raspberry. Burl., Sept. 1891; C. 2024. Newfane, Sept. 1892; G. 328.

CLAVICEPS PURPUREA (Fr.) Tul. (?) Sclerotium stage only.

On ovaries of Dactylis glomerata, Orchard grass. Burl., July, 1898; J. 2032.

On ovaries of Festuca pratensis, Fescue. Burl., Aug. 1890; J. 2031.

On ovaries of Secale cereale, Rye. Burl., July, 1898; O. 2029.

DIATRYPE VIRESCENS (Schw.) Cke.

On branches of Fagus ferruginea, Beech. Johnson, April, 1895; G. 366.

DIMEROSPORIUM COLLINSII (Schw.) Thŭm.

On Amelanchier sp., Juneberry. Burl., June, 1893; J. 2023.

EUROTIUM HERBARIORUM (Wigg.) Lk.

On Ranunculus abortivus in herbarium. Burl., 1897; J. 3004.

GNOMONIA FIMBRIATA (Pers.) Awd.

On Carpinus Caroliniana, Blue beech. Newfane, Oct. 1892; G. 337. Beaver, Sept. 1897; O. 2022.

GNOMONIA ULMEA (Sacc.) Thŭm.

On Ulmus Americana, Elm. Burl., Oct. 1891; C. 2018. Walden, Aug. 1898; O. 2017.

HYPOXYLON COHAERENS (Pers.) Fr.

On limbs of Fagus ferruginea, Beech. Johnson, May, 1895; G. 339.

LAESTADIA COPTIS (Schw.) E. & E. (*Sphaerella Coptis* Schw.)

On Coptis trifolia, Gold-thread. Burl., June, 1898; O. 2742.

LOPHODERMIUM PINASTRI (Schrad.) Chev.

On Pinus rigida, Pitch pine. Burl., Oct. 1897; O. 2021.

On Pinus Strobus, White pine. Burl., Oct. 1897; O. 2020. Injurious.

LOPHODERMIUM RHODODENDRI (Schw.) E. & E.

On Rhododendron maximum, Groton Pond. July, 1898; J. 2610.

MASSARIELLA BUFONIA (B. & Br.) Speg.

On bark of Prunus Pennsylvanica, Cherry. Johnson, May, 1895; G. 348.

[1] SPHÆRELLA COLORATA Pk.

On Kalmia angustifolia, Laurel. Colchester, May, 1898; O. 2738.

SPHÆRELLA DAHLIÆ C. & E.

On Dahlia variabilis, Dahlia. Burl., Sept. 1898; O. 2458.

SPHÆRELLA FRAGARIÆ (Tul.) Sacc.

On Fragaria Chiloensis, Cultivated strawberry. Isle La Motte, Oct. 1898; O. 2014.

On Fragaria vesca. Burl., Aug. 1897; O. 2016.

On Fragaria Virginiana. Burl., Aug. 1897; O. 2015.

SPHÆRELLA IMPATIENTIS Pk. & Cl.

On Impatiens fulva, Jewel-weed. Waterbury Ctr., Aug. 1898; O. 2735.

SPHÆRELLA THALICTRI E. & E.

On Thalictrum dioicum, Meadow-rue. Burl., July, 1897; O. 2459.

NECTRIA CINNABARINA (Tode) Fr.

On Betula lutea, Yellow birch. Jeffersonville, Mar. 1898; O. 3029.

On Acer saccharinum, Sugar maple. Waterbury Ctr., April, 1898; O. 3032. (Conidial stage.)

NECTRIA COCCINEA (Pers.) Fr.

On Acer Pennsylvanicum, Striped maple. Burl., Oct. 1898; O. 3040.

PHYLLACHORA FLABELLA (Sch.) Thŭm.

On Pteris aquilina, Brake. Grafton, Aug. 1899; G. A. Woolson, 3770.

PHYLLACHORA GRAMINIS (Pers.) Fckl.

On Agropyron repens, Witch-grass. Burl., Oct. 1896; J. 2005.

On Asprella hystrix. Burl., July, 1897; O. 2007.

On Elymus Canadensis, Wild rye. Burl., Oct. 1891; C. 2006.

On Muhlenbergia glomerata. Smuggler's Notch, Aug. 1893; G. 370.

On Oryzopsis asperifolia. Richmond, Aug. 1898; H. 2008.

On Sporobolus serotinus. Newfane, Sept. 1892; G. 350.

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1 These species are placed by some authorities under the genus *Mycosphærella* Johans.

PHYLLACHORA OXALINA E. & E.

On Oxalis corniculata var. stricta. Johnson, Sept. 1893; G. In Herb. Ellis at Columbia.

PHYLLACHORA POMIGENA (Schw.) (*Dothidea pomigena* Schw.)

On fruit of Pyrus Malus, apple. Producing "Sooty mold." Burl., Sept. 1897; O. 2061.

[See foot note page 159 of this report.]

PHYLLACHORA TRIFOLII (Pers.) Fckl. (*Polythrincium Trifolii* Kze.)

On Trifolium hybridum, Alsike clover. Burl., Aug. 1897; O. 2002.

On Trifolium pratense, Red clover. Burl., Oct. 1890; C. 2003.

On Trifolium repens, White clover. Burl., Oct. 1898; H. 2734. Common.

PLOWRIGHTIA MORBOSA (Schw) Sacc.

On branches of Prunus domestica, Plum. Burl., May, 1898; O. 2036.

On branches of Prunus sp. Plum. Charlotte, July, 1898; Waugh 2035. Brookline, Feb. 1899; O. 2227.

On branches of Prunus Cerasus, Cherry. Burl., Feb. 1999; O. 2330.

STIGMATEA ROBERTIANA Fr.

On Geranium Robertianum, Herb Robert. Burl., Oct. 1890; O. 2457.

VALSA AMBIENS (Pers.) Fr.

On dead branches of Fagus ferruginea, Beech. Johnson, April, 1895; G. 363.

On dead branches of Pyrus Malus, Apple. Johnson, G. 728.

VALSA NIVEA (Hoffm.) Fr.

On branches of Populus tremuloides, Poplar. Johnson, June, 1895; G. 364. Burl., Sept. 1898; O. 2001.

VALSA QUARTERNATA (Pers.) Fr.

On branches of Acer rubrum, Red maple. Johnson, April, 1895; G. 365.

XYLARIA CORNIFORMIS Fr.

On a decaying log, Smugglers' Notch, Sept. 1897; J. 2145.

XYLARIA DIGITATA L.

On a decaying log of Fagus ferruginea, Beech. Smugglers' Notch, Sept. 1897; J. 2146.

DISCOMYCETES[1]

CUDONIA CIRCINANS (Pers.) Fr.

On dead leaves. Burl., Aug. 1897; J. 2147.

LEOTIA LUBRICATA Pers.

On the ground in wet places. Newfane, Aug. 1897; C. D. Howe; 2141.

MITRULA VITELLINA (Bris.) Sacc. var. IRREGULARIS Pk.

On the ground. Mt. Mansfield, Sept. 1897; J. 2150.

MORCHELLA ANGUSTICEPS Pk.

On the ground. Williamstown, May, 1897; L. B. Roberts, 2151. Burl. May, 1898; J.

MORCHELLA ESCULENTA Pers.

On the ground. Burl., May, 1897, J. 2152.

PEZIZA DEHNII Rab.

On stems and petioles of living Potentilla argentea, Cinquefoil. Burl., June, 1897; O. 2054. This fungus causes the plant attacked to become dwarfed and more bushy.

On stems and petioles of Potentilla Norvegica. Burl., July, 1898; H. 2057.

PEZIZA UNCISA Pk.

In wet moss on ledges. Newfane, Sept. 1897; C. D. Howe, 2062.

PSEUDOPEZIZA MEDICAGINIS (Lib.) Sacc.

On Medicago lupulina, Medick. Burl., July, 1898; H. 2058.

On Medicago sativa, Alfalfa. Burl., July, 1898; G. 2059.

RHYTISMA ACERINUM (Pers.) Fr.

On Acer dasycarpum, Silver maple. Burl., Oct. 1895; J. and O. 2044.

RHYTISMA ANDROMEDAE (Pers.) Fr.

On Kalmia glauca, Laurel. Stratton, July, 1895; J. 2045.

RHYTISMA ASTERIS Schw.

On Aster paniculatus. Burl., Oct. 1897; O. 2037.

RHYTISMA ILICIS-CANADENSIS Schw.

On Ilex verticillata, Winterberry. Beaver, Sept. 1897; O. 2046. Burl., July, 1898; O. 2048.

On Nemopanthes fascicularis, Holly. Stratton, Aug. 1892; G. 397; Belden Pond, Sept. 1894; G. 396. Johnson, Sept. 1894; G. 688. Burl., July, 1898; O. 2047.

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1 See also Vermont Helvelleæ, with descriptive notes. E. A. Burt. Rhodora 1, p. 59 (1899).

RHYTISMA PUNCTATUM (Pers.) Fr.

On Acer Pennsylvanicum, Striped maple. Burl., Oct. 1897; O. 2039.

On Acer spicatum, Mountain maple. Burl., Aug. 1892; J. 2041. Newfane, Sept. 1892; G. 394. Beaver, Sept. 1897; O. 2038. Walden, Aug. 1898; O. 2040.

RHYTISMA SALICINUM (Pers.) Fr.

On Salix cordata, Willow. Burl., Oct. 1897; O. 2050. Beaver, Sept. 1897; O. 2049.

RHYTISMA SOLIDAGINIS Schw.

On Solidago lanceolata, Golden-rod. Strafford, July, 1891; C. 2052. Newfane, Aug. 1892; G. 393.

SPATHULARIA CLAVATA (Schaeff.) Sacc.

On moist soil, Newfane, July, 1897. C. D. Howe, 2154.

SPATHULARIA FLAVIDA Pers.

On soil, Middlebury. Burt. 2155.

[1] HYMENOMYCETEÆ

EXOBASIDIUM VACCINII (Fckl.) Wor.

On Arctostaphylos Uva-Ursi, Bearberry. Snake Mt., July, 1898; O. 2143.

On Cassandra calyculata. Burl., June, 1896; G. 2138. Snake Mt., July, 1898; O. 2137.

On Vaccinium Cxycoccus. Mt. Mansfield, Aug. 1898; J. 2141.

On Vaccinium vacillans, Blueberry. Burl., June, 1896; G. 2139. Snake Mt., July, 1898; O. 2142.

FUNGI IMPERFECTI

SPHAEROPSIDEÆ

ACTINONEMA ROSAE (Lib.) Fr.

On Rosa sp., Cultivated rose. Burl., Jan. 1894; J. 483. Charlotte, Sept. 1898; O. 2764.

ASCOCHYTA FAGOPYRI Bres.

On Fagopyrum esculentum, Buckwheat. Beaver, Sept. 1897; O. 2737.

Apparently different from *A. Fagopyri* Thüm., which was described earlier and would have precedence under the laws of priority.

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1 The remaining genera of Hymenomycetes are not included here as they do not properly come into a list of this character and since Dr. E. A. Burt of Middlebury college has in preparation a full list of this group.

ASCOCHYTA RHEI E. & E.

On Rheum Rhaponticum Rhubarb. Burl., Sept. 1898; O. 2996.

CICINOBOLUS CESATII De By.

On Erysiphe Cichoracearum, on various hosts. Burl., Sept. 1897; O. 785.

CORNULARIA PERSICAE (Schw.) Sacc.

On branches of Prunus Pennsylvanica, Wild cherry. Johnson, Apr. 1895; G. 480.

DARLUCA FILUM (Biv.) Cast.

On Coleosporium Sonchi. Burl., Aug. 1896; G. 2348.

On Uromyces Junci. Newfane, Oct. 1892; G. 2940.

ENTOMOSPORIUM MACULATUM Lev.

On Pyrus communis, Pear. Burl., Sept. 1898; J. 2963.

On Pyrus Cydonia, Quince. Burl., Oct. 1890; C. 3003.

LEPTOTHYRIUM POMI (Mont. & Fr.) Sacc.

On fruit of Pyrus Malus, Apple. "Fly speck fungus." Burl., Oct. 1897; O. 2977.

PHYLLOSTICTA ACERICOLA C. & E.

On Acer rubrum, Red maple. Burl., July, 1897; O. 3014.

On Acer saccharinum, Sugar maple. Beaver, Sept. 1897; O. 3015.

PHYLLOSTICTA AMPELOPSIDIS E. & M.

On Ampelopsis quinquefolia, Woodbine. Burl., Aug. 1897; O. 2377.

PHYLLOSTICTA BETAE Oud.

On Beta vulgaris, Beet. Walden, Aug. 1898; O. 2979. Burl., Sept. 1898; O. 2777.

PHYLLOSTICTA CORNICOLA (DC.) Rabh.

On Cornus alternifolia, Dogwood. Burl., Sept. 1897; O. 2717.

On Cornus circinata. Burl., Sept. 1897; O. 2718.

PHYLLOSTICTA CRUENTA (Fr.) Kx.

On Smilacina racemosa, False spikenard. Burl., July, 1898; O. 2728.

On Smilacina stellata. Burl., Aug. 1897; O. 2769.

PHYLLOSTICTA DECIDUA E. & E.

On Mentha piperita, Peppermint. Burl., July, 1898; H. 2980.

PHYLLOSTICTA ELLISIANA Lamb. & Fautr.

On Anemone Virginiana, Anemone. Providence Island, June, 1898; H. & O. 2981.

PHYLLOSTICTA FATISCENS Pk.

On Nymphaea odorata, Water lily. Burl., Aug. 1898; O. 3028.

PHYLLOSTICTA GAULTHERIAE E. & E.

On Gaultheria procumbens, Wintergreen. Burl., July, 1897; O. 2380.

PHYLLOSTICTA NESAEAE Pk.

On Decodon verticillaris. Burl., Aug. 1898; O. 2981.

PHYLLOSTICTA PYRINA Sacc.

On Pyrus Malus, Apple. Burl., Aug. 1897; O. 2371. Isle La Motte, Oct. 1897: J. 3034.

PHYLLOSTICTA QUERCUS-RUBRAE W. R. Ger.

On Quercus rubra, Red oak. Charlotte, Sept. 1897; O. 2982.

PHYLLOSTICTA TINEA Sacc.

On Viburnum lantanoides, Hobble-bush. Newfane, Sept. 1892; G. 436. Stratton, Aug. 1894: G. 484.

PHYLLOSTICTA ULMICOLA Sacc.

On Ulmus campestris, Elm. Burl., Aug. 1897; O. 2982.

PHYLLOSTICTA VARIABILIS Pk.

On Rubus odoratus, Flowering raspberry. No. Calais, Aug. 1898; O. 2710.

PIGGOTIA FRAXINI B. & C.

On Fraxinus pubescens, Red ash. Newfane, Sept. 1892; G. 2012. Beaver, Sept. 1897; O. 2011.

SEPTORIA ACERINA Pk.

On Acer Pennsylvanicum, Striped maple. Newfane, Aug. 1892; G. 593. Burl., Aug. 1897; O. 2385. Beaver, Sept. 1897; O. 2375. Snake Mt., July, 1898; J. 2724.

SEPTORIA ANEMONES Desm.

On Anemone Virginiana. Providence Island, June, 1898; H. and O. 2987.

SEPTORIA AQUILEGIAE Penz. & Sacc.

On Aquilegia Canadensis, Honeysuckle. Burl., June, 1896; G. 2382.

SEPTORIA ASTRAGALI Desm.

On Lathyrus maritimus, Beach pea. Burl., Sept. 1898; O. 2791.

SEPTORIA ATROPURPUREA Pk.

On Aster cordifolius. Newfane, Aug. 1892; G. 454.

SEPTORIA BETULICOLA Pk.

On Betula lenta, Sweet birch. Burl., July, 1897; O. 3038.

On Betula populifolia, White birch. Burl., July, 1897; O. 2988.

SEPTORIA BRUNELLAE E. & H.

On Brunella vulgaris, Self heal. Burl., Aug. 1897; O. 2989.

SEPTORIA BRUNNEOLA (Fr.) Niessl.

On Smilacina racemosa, False spikenard. Burl., Sept. 1897; O. 3012.

SEPTORIA CHRYSANTHEMI Allesch.

On Chrysanthemum Leucanthemum, White daisy. Burl., Aug. 1897; O. 3025. Manchester, Sept. 1898; J. 3026.

This is apparently distinct from the species distributed by Cavara as *Septoria Chrysanthemi*, and which Saccordo lists under the name *S. Chrysanthemella* Cav., and also from *Septoria Chrysanthemi* Halsted.

SEPTORIA CIRSII Niessl.

On Cnicus arvensis, Canada thistle. Walden, Aug. 1898; O. 2722.

SEPTORIA CONSPICUA E. & M.

On Steironema ciliatum. Johnson, July, 1893; G. 472. Beaver, Sept. 1897; O. 2342.

SEPTORIA COPTIDIS B. & C.

On Coptis trifolia, Goldthread. Burl., June, 1898; O. 2743.

SEPTORIA CONVOLVULI Desm.

On Convolvulus sepium, Hedge bindweed. Burl., July, 1898; O. 2990.

SEPTORIA CORNICOLA Desm.

On Cornus alternifolia, Dogwood. Mt. Mansfield, June, 1897; O. 2707. Beaver, Aug. 1897; O. 2715. Manchester, Sept. 1898; J 2802.

SEPTORIA CORYLINA Pk.

On Corylus rostrata, Hazelnut. Walden, Aug. 1898; O. 3037.

SEPTORIA CUCURBITACEARUM Sacc.

On Cucumis Melo, Muskmelon. Burl., Sept. 1898; J. 3024.

SEPTORIA DALIBARDAE Pk.

On Dalibarda repens. Burl., Aug. 1897; O. 2740.

SEPTORIA DIANTHI Desm.

On Dianthus caryophyllus, Carnation. Burl., Dec. 1892; J. 460.

SEPTORIA DIVARICATA E. & E.

On Phlox paniculata, Phlox. Burl., Sept. 1898; O. 2990.

SEPTORIA EPILOBII West.

On Epilobium adenocaulon, Willow-herb. Burl., Aug. 1898; O. & H. 2746.

SEPTORIA FAIRMANI E. & E.

On Althæa rosea, Hollyhock. Charlotte, Aug. 1897; O. 2366. Quite injurious to young plants.

SEPTORIA GALEOPSIDIS West.

On Galeopsis Tetrahit, Hemp Nettle. Johnson, Sept. 1894; G. 474. Burl., July, 1898; O. 2779. No. Calais, Aug. 1898; O. 2713.

SEPTORIA GEI Rob. & Desm.

On Geum macrophyllum, Avens. Walden, Aug., 1898; O. 2991.

SEPTORIA HIPPOCASTANI Berk & Br.

On Aesculus Hippocastanum, Horsechestnut. North Hero, Sept. 1897: J. 2351.

SEPTORIA INCRESCENS Pk.

On Trientalis Americana. Star flower. Burl., Aug. 1897; O. 2340.

SEPTORIA LEPTOSTACHYÆ E. & K.

On Phryma Leptostachya, Lopseed. Newfane, July, 1894; G. 477.

SEPTORIA LOBELIÆ Pk.

On Lobelia cardinalis, Cardinal flower. Charlotte, Aug. 1897; O. 2379.

SEPTORIA LYCOPERSICI Speg.

On Lycopersicum esculentum, Tomato. Burl., Sept. 1898; O. 2466.

SEPTORIA MALVICOLA E. & M.

On Malva rotundifolia, Mallow. Burl., Oct. 1890; G. 2462. North Calais, Aug. 1898; O. 2714.

SEPTORIA MUSIVA Pk.

On Populus monilifera, Cottonwood. Burl., Aug. 1897; O. 2460.

SEPTORIA NABALI B. & C.

On Prenanthes sp., Rattlesnake root. Mt. Mansfield, June, 1897; O. 2794.

SEPTORIA ŒNOTHERÆ West.

On Œnothera biennis, Evening primrose. Burl., Aug. 1890; J. 2468. Johnson, July, 1893; G. 476.

On Œnothera Oakesiana, Burl., Aug. 1898; H. 2386.

On Œnothera pumila. Burl., Aug. 1897; O. 2386.

SEPTORIA PISI West.

On Pisum sativum, Pea. Burl., July, 1898; J. 2770.

SEPTORIA POLYGONORUM Desm.

On Polygonum dumetorum var. scandens, Climbing false buckwheat. Beaver, Sept. 1897; O. 2992.

On Polygonum Persicaria, Smartweed. Burl., July, 1897; O. 2706. Beaver, Sept. 1897; O. 2368.

SEPTORIA POPULICOLA Pk.

On Populus balsamifera, Balm of Gilead. Providence Island, June, 1898 ; O. 2720.

SEPTORIA RHOINA B. & C.

On Rhus glabra, Sumach. Burl., Aug. 1897 ; O. 2384.

On Rhus typhina. Johnson, Sept. 1894 ; G. 705.

SEPTORIA RIBIS Desm.

On Ribes nigrum, Black currant. Burl., Aug. 1897 ; O. 2341.

On Ribes prostratum. Fetid currant. Mt. Mansfield, Aug. 1898 ; J. 2747.

On Ribes rubrum, Red currant. Underhill, July, 1898 ; J. 2745, Walden, Aug. 1898 ; O. 2721.

SEPTORIA RUBI West.

On Rubus hispidus, Swamp blackberry. Burl., July, 1897 ; O. 2369.

On Rubus occidentalis, Black raspberry. South Hero, Nov. 1897 ; O. 2463.

On Rubus villosus, Blackberry. Newfane, Aug. 1892 ; G. 469. Burl., Oct. 1896 ; G. 2324. North Calais, Aug. 1890 ; O. 2711.

SEPTORIA SACCHARINI E. & E.

On Acer saccharinum, Sugar maple. Newfane, Aug. 1892 ; G. 471. Walden, Aug. 1898 ; O. 2723.

SEPTORIA SAMBUCINA Pk.

On Sambucus Canadensis, Elderberry. Beaver, Sept. 1797 ; O. 2709.

SEPTORIA SEDI West.

On Sedum Telephium, Liveforever. North Calais, Aug. 1898 ; O. 3027. Abundant and destructive to this weed. Observed at Burlington and various other localities in Vermont. Probably occurs commonly on this host throughout the state.

SEPTORIA SMILACINÆ E. & M.

On Smilacina racemosa, False spikenard. Burl., Aug. 1890 ; J. 2482.

SEPTORIA TRILLII Pk.

On Trillium grandiflorum, Trillium. Burl., June, 1897 ; O. 2708.

SEPTORIA VERBASCICOLA B. & C.

On Verbascum Blattaria, Moth mullein. East Dorset, Aug. 1894 ; G. 703.

SEPTORIA VERBENÆ Rob. & Desm.

On Verbena hastata, Blue vervain. Burl., July, 1896 ; O. 2374. Beaver, Sept. 1897 ; O. 2349.

On Verbena urticæfolia, White vervain. Burl., Aug. 1887 ; O. 2373.

SEPTORIA VIOLÆ West.

On Viola blanda, Violet. Beaver, Sept. 1897; O. 2378. Underhill, July, 1898; J. 2719.

On Viola canina var. Muhlenbergii. Burl., 1897; O. 2730.

On Viola lanceolata. Vernon, July, 1895; G. 475.

SEPTORIA VIRIDI-TINGENS Curt.

On Allium tricoccum, Wild leek. Smugglers' Notch, June, 1895; J. 2469.

SEPTORIA WALDSTEINIÆ Pk. & Cl.

On Waldsteinia fragarioides, Barren strawberry. Charlotte, Sept. 1897; O. 2773. Burl., May, 1898; O. 2726.

SEPTORIA WILSONI Cl.

On Chelone glabra, Snake-head. Stratton, Aug. 1894; G. 701. Burl., Sept. 1896; G. 2383. Beaver, Aug. 1897; O. 2636.

STAGONOSPORA EQUISETI Fautr.

On Equisetum limosum, Scouring rush. Burl., Sept. 1898; O. 3031.

VERMICULARIA COPTINA Pk.

On Coptis trifolia, Goldthread. Burl., Aug. 1897; O. 2739.

VERMICULARIA PECKII var. VIOLÆ-ROTUNDIFOLIÆ Sacc.

On Viola rotundifolia, Violet. Johnson, June, 1895; J. 2474.

VERMICULARIA SUBEFFIGURATA Schw.

On Tragopogon porrifolius, Salsify. Johnson, Oct. 1894; G. 481.

MELANCONIEÆ

COLLETOTRICHUM LAGENARIUM (Pass.) Ell. & Hals.

On fruit of Cucumis Melo, Muskmelon. Burl., Sept. 1806; G. 2935.

COLLETOTRICHUM LINDEMUTHIANUM (Sacc. & Mag.) Scrib.

On Phaseolus vulgaris, Bean. Burl., 1892; J. 2937.

On Pisum sativum, Pea. Beaver, Sept. 1897; O. 2354.

CYLINDROSPORIUM PADI Karst. (*Septoria cerasina* Pk.)

On Prunus serotina, Black cherry. Newfane, Sept. 1892.

On Prunus sp., Cultivated cherry. Pittsford, July, 1896; J. 507.

On Prunus Armeniaca, Apricot. Colchester, Aug. 1896; G. 3002.

On Prunus sp., Plum. Burl., Sept. 1898; O. 3030.

CYLINDROSPORIUM SACCHARINUM E. & E.

On Acer rubrum, Red Maple. Stratton, 1894; G. 508.

CYLINDROSPORIUM TOXICODENDRI (Curt.) E. & E. (*Septoria Toxicodendri* Curt.)

On Rhus Toxicodendron, Poison ivy. Burl., July, 1898; O. 2741.

GLOEOSPORIUM ACERINUM West.

On keys of Acer Pennsylvanicum, Striped maple. Belden Pond, Sept. 1894; G. 2973. (Var. *fructigenum* E. & E.)

GLOEOSPORIUM BOREALE E. & E.

On Salix cordata, Willow. Johnson, Sept. 1894; G. 632.

On Salix sp. Newfane, Sept. 1892; G. 490.

GLOEOSPORIUM CORYLI (Desm.) Sacc.

On Corylus rostrata, Hazelnut. Burl., Aug. 1897; O. 3035.

GLOEOSPORIUM RIBIS (Lib.) Mont. & Desm.

On Ribes rubrum, Red currant. Burl., Aug. 1896; G. 3016.

GLOEOSPORIUM VENETUM Speg.

On Rubus strigosus. Red raspberry. Burl., Aug. 1890; J. 2974.

MARSONIA JUGLANDIS (Lib.) Sacc.

On Juglans cinerea, Butternut. Johnson, Sept. 1893; G. 510.

HYPHOMYCETEÆ

ALTERNARIA FASCICULATA (C. & E.) Jones & Grout (*Macrosporium chartarum* Pk. (Not Preuss.); *M. fasciculatum* C. & E.; *M. Maydis* C. & E.; *M. Tomato* Cooke. See Bul. Torr. Bot. Club, 24, pp. 254-258, 1897).

On Allium Cepa, Onion. Milton, Sept. 1896; Herrick, 265.

On Asclepias incarnata, Swamp milkweed. Burl., Oct. 1895; G. 2911.

On Asparagus officinale, Asparagus. Burl., Oct. 1897; O. 2332.

On Aster sp., Cultivated aster. Burl., Sept. 1896; G. 2999.

On Avena sativa, Oat. Burl., Aug. 1896; G. 380.

On Brassica alba, Mustard. Burl., Sept. 1896; G. 2910.

On Brassica oleracea, Cabbage. Burl., Aug. 1896; G. 382.

On Dahlia variabilis, Dahlia. Burl., Sept. 1898; O. 2480.

On Fagopyrum esculentum, Buckwheat. Burl., Sept. 1892; G. 2903.

On Gladiolus sp., Cultivated gladiolus. Charlotte, Sept. 1897; O. 3018.

On Lathyrus palustris. Gardener's Island, Aug. 1896; G. 431.

On Lycopersicum esculentum, Tomato. Burl., Sep. 1892; Tracy, 2905.

On old pasteboard exposed to the weather. Milton, Aug. 1896; G. 2904.

On Phaseolus vulgaris, Bean. Burl., July, 1896; G. 296.

On Raphanus sativus, Radish. Burl., Aug. 1896; S. 2909.

On Solanum tuberosum, Potato. Bradford, July, 1893; Tracy, 2914. Burl., Aug. 1894; Tracy, 2915. Dorset, Aug. 1895; Tracy, 2913.

On Zea Mays, Indian corn. Burl., Aug. 1896. G. 381.

ALTERNARIA SOLANI (E. & M.) Jones and Grout. (*Alternaria Solani* Sorauer in part; *Macrosporium Solani* E. & M.)

On Datura Tatula, Jamestown weed. Manchester, Sept. 1898; J. 2481.

On Lycopersicum esculentum, Tomato. Burl., Sept. 1896; G. 3000.

On Solanum tuberosum, Potato. Burl., Aug. 1892; J. 2921. Barton, Aug. 1892; J. 385. Pownal, Aug. 1892; J. 384.

BOTRYTIS VULGARIS Fr.

On Dianthus caryophyllus, Carnation. Burl., Jan. 1892; J. 276.

On Erythronium Americanum. Johnson, May, 1895; G. 263.

On Lactuca sativa, Lettuce. Burl., Jan. 1893; J. 264.

On Lilium Canadense. Johnson, July, 1893; G. 511.

BOTRYTIS sp., (the lily botrytis of Marshall Ward, Ann. Bot. 2; pp. 319-382, 1888-89.)

On Lilium candidum, Lily. Burl. July, 1896; J. & G. 326.

On Lilium speciosum. Charlotte, Sept. 1897; O. 2997.

On Lilium tigrinum. Charlotte, Sept. 1897; O. 2998.

CERCOSPORA AMPELOPSIDIS Pk.

On Ampelopsis quinquefolia, Woodbine. Burl., Aug. 1897; O. 2772.

CERCOSPORA APII Fr.

On Apium graveolens, Celery. Burl., Aug. 1894; J. 2461.

CERCOSPORA BETICOLA Sacc.

On Beta vulgaris, Beet. Burl., Oct. 1890; C. 2467.

CERCOSPORA CAULOPHYLLI Pk.

On Caulophyllum thalictroides. Johnson, Aug. 1893; G. 272.

CERCOSPORA CIRCUMSCISSA Sacc.

On Prunus serotina, Black cherry. Newfane, Sept. 1892; G. 2928.

On Prunus Virginiana, Choke cherry. Burl., July, 1898; O. 2929. Walden, Aug. 1898; O. 2930.

CERCOSPORA CLAVATA (Ger.) Pk.

On Asclepias Cornuti, Milkweed. Burl., Aug. 1890; J. 3006.

CERCOSPORA DUBIA (Riess.) Wint.

On Chenopodium album, Pigweed. Burl., Aug. 1892; J. 2793.

CERCOSPORA GRANULIFORMIS Ell. & Holw.

On Viola palmata var. cucullata, Violet. Burl., Aug. 1892; J. 2476.

On Viola pubescens. Burl., Aug. 1890; J. 2477.

CERCOSPORA MALI E. & E.

On Pyrus Malus, Apple. Burl., Aug. 1891; J. 2473. Walden, Aug. 1898; O. 2781.

CERCOSPORA MICROSORA Sacc.

On Tilia Americana, Basswood. Providence Island, June, 1898; O. 2931. Snake Mountain, July, 1898; O. 2932.

CERCOSPORA SAGITTARIÆ E. & K.

On Sagittaria variabilis, Arrowhead. West Townshend, Aug. 1894; G. 617.

CERCOSPORA SQALIDULA Pk.

On Clematis Virginiana, Virgin's bower. Newfane, Sept. 1892; G. 2333. Beaver, Aug. 1897; O. 2335.

CERCOSPORA VIOLÆ Sacc.

On Viola sp., Cultivated violet. Burl., Sept. 1898; O. 2800.

CERCOSPORELLA CANA (Pass.) Sacc.

On Erigeron annuus, Daisy fleabane, Isle La Motte, Oct. 1898; O. 3007.

CLADOSPORIUM FULVUM Cke.

On Lycopersicum esculentum, Tomato. Burl., Jan. 1893; J. 275. Injurious in the greenhouse.

On Solanum tuberosum, Potato. Burl., July, 1893; J. 2934. Dorset, July, 1894; Tracy, 2933.

CLADOSPORIUM HERBARUM (Pers.) Lk.

On Populus tremuloides, Poplar. Newfane, Sept. 1892; G, 288.

On dead wood of Tilia Americana, Basswood. Johnson, June, 1895; G. 274.

CLADOSPORIUM RAMULOSUM Desm.

On Populus tremuloides, Poplar. Burl., Aug. 1897; O. 2483.

FUSICLADIUM DENDRICTICUM (Wallr.) Fckl.

On Pyrus Malus, Apple. Burl., Sept. 1894; J. 2968. Isle La Motte, Oct. 1898; O. 2967. Walden, Aug. 1898; O. 2782.

FUSICLADIUM DEPRESSUM (B. & Br.) Sacc.

On Angelica atropurpurea. Johnson, Sept. 1893; G. 2970.

FUSICLADIUM PYRINUM (Lib.) Fckl.

On leaves and fruit of Pyrus communis, Pear. No. Calais, Aug. 1898; O. 2971. Burl., Sept. 1898; O. 2972.

HETEROSPORIUM GRACILE (Wallr.) Sacc.

On Belamcanda Chinensis, Blackberry lily. Charlotte, July, 1896; G. 299.

On Iris sp., Cultivated iris. Charlotte, Sept. 1897; O. 2975. Burl., Sept. 1898; O. 2976.

MACROSPORIUM PORRI Ell.

On Allium Cepa, Onion. Milton, June, 1896; G. 2979.

MACROSPORIUM SARCINULA Berk. var. PARASITICUM Thüm.

On Allium Cepa, Onion. Milton, Sept. 1896; Herrick, 301.

MICROSTROMA JUGLANDIS (Berang.) Sacc.

On Carya alba, Shellbark hickory. Burl., July, 1897; O. 2796.

MONILIA FRUCTIGENA Pers.

On Prunus domestica, Plum. So. Hero, Oct. 1898; O. 3005.

OVULARIA SOMMERI (Eichelbaum) Sacc.

On young stems of Myrica Gale, Sweet gale. Burl., May, 1897; J. & O. 2736.

PENICILLIUM GLAUCUM Grev.

On fruit of Pyrus Malus, Apple. Burl., Jan. 1892; J. 376.

PIRICULARIA GRISEA (Cke.) Sacc.

On Setaria glauca, Pigeon grass. Burl., July, 1897; O. 3008.

RAMULARIA ACTEÆ E. & H.

On Actea alba, White baneberry. Newfane, June, 1892; G. 308.

RAMULARIA ARMORACIAE Fckl.

On Nasturtium Armoracia, Horseradish. Milton, Sept. 1896; G. 3023.

RAMULARIA ARVENSIS Sacc.

On Potentilla Norvegica, Cinquefoil. Burl., June, 1898; O. 2727.

RAMULARIA CELASTRI Pk.

On Celastrus scandens, Bittersweet. Newfane, Sept. 1895; G. 310. Burl., Aug. 1897; O. 2370. No. Calais, Aug. 1898; O. 2712.

RAMULARIA DECIPIENS E. & E.

On Rumex crispus. Dock. Burl., Aug. 1897; O. 2986.

RAMULARIA IMPATIENTIS Pk.

On Impatiens fulva, Jewel weed, Beaver, Aug. 1897; O. 2797.

RAMULARIA NEMOPANTHES Pk.

On Nemopanthes fascicularis. Burl., July, 1898; O. 3020.

RAMULARIA OXALIDIS Farl.

On Oxalis acetosella, Woodsorrel. Stratton, July, 1894; G. 692.

RAMULARIA PLANTAGINIS E. & M.

On Plantago major, Plantain. Stratton, Aug. 1894; G. 691.

RAMULARIA RANUNCULI Pk.

On Ranunculus acris, Buttercup. Walden, Aug. 1898. O. 3019.

RAMULARIA RUDBECKIAE Pk.

On Rudbeckia laciniata, Cone-flower. Vernon, Aug. 1895; G. 690.

RAMULARIA TARAXACI Karst.

On Taraxacum officinale, Dandelion. Burl., July, 1897; O. 3013.

RAMULARIA URTICAE Ces.

On Urtica gracilis, Nettle. Burl., Sept. 1897; O. 2795.

SCOLECOTRICHUM GRAMINIS Fckl.

On Dactylis glomerata, Orchard grass. Burl., Sept. 1896. G. 3011.

KILLING WEEDS WITH CHEMICALS

Since the publication in a recent bulletin[1] of the successful results from the use of salt in killing the orange hawkweed many inquiries have been received as to the possibility of destroying a variety of other weeds with chemical agents.

The great difficulty in the practical use of chemicals as weed killers is in managing to kill the weeds without either destroying neighboring useful plants or leaving the soil so impregnated with the chemical as to interfere with the growth of useful plants thereafter. These difficulties interfere with the general usefulness of chemicals as weed destroyers. There are two cases where chemicals may be resorted to in spite of them. First, where an especially dangerous or obnoxious weed occurs in a limited locality and it is desired to destroy it quickly and utterly; and, second, where the soil to be freed from weeds is not thereafter to be used for the growth of other plants, as in the case of gravel walks and roads, or those paved loosely with stone or wooden blocks, and also in tennis courts and similar areas.

Since numerous inquiries have concerned such cases it was decided to make a comparative test of a number of chemicals for these purposes. These tests have included the following: common salt, copper sulphate, sulphide of potassium, kerosene, arseniate of soda, and a mixture of white arsenic and sal soda, in addition to two proprietary articles described later. The details of this work were carried out at this station by Messrs. T. E. Hazen, a graduate student in its employ, and A. W. Edson.

The chemicals were tested by marking off areas in gravel walks, roadways, tennis courts and similar dry beaten soils, noting the character of the weed growth and observing the effect upon this of the applications of various chemicals. These applications were begun about July 1st and observations continued until autumn. In some cases the walks were occupied by weeds of considerable size, in others they had recently been hoed and raked over. The solutions were applied in all cases with an ordinary water-

1. Vt. Exp. Sta. Bul. 56, (1897.)

ing pot. It was found by experience that about eight gallons of solution was required effectively to wet down one square rod of such soil and that amount was used in most of this work. The results may best be presented topically as follows:

Nature of the weeds.—The knot-weed or knot-grass (*Polygonum aviculare* Linn.) was the most troublesome weed in the areas under observation. White clover and several of the annual grasses occurred commonly also (setarias and panicums especially) and in certain of the plots the perennial grasses, Kentucky blue and quack (*Agropyron repens*) were abundant. Purslane, plantains, blue-curls, dandelion and some other weeds occurred in some of the plots. Of these the knot-weed was distinctly the most troublesome, and the efficaciousness of a chemical in destroying this was considered the best gage of its value.

SALT

Common salt, sodium chloride, was tried upon gravel containing the knot-grass (Polygonum aviculare) and some of the coarser grasses (panicums, etc.) It was applied dry in amounts varying from four to twenty pounds per square rod, and in one case it was used in a larger but unmeasured quantity. It was found to be slow and imperfect in its action as a weed killer under these circumstances. Moreover, it washed into the grass borders and injured them considerably in case of rains. We are led to decide for these reasons that salt is not to be recommended for such weed killing. It has heretofore been shown that salt has a distinct practical value for killing the orange hawkweed, and that the larger of the amounts cited above is sufficient to eradicate that weed. There may be exceptional circumstances when the use of salt on roadways may be wise. Thus the superintendent of the Boston parks writes us that he obtains refuse salt at $1.00 per ton, which he uses freely and successfully on such of their roadways as permit of no danger to adjacent lawns or trees. True[1] finds that salt has slight toxic (poisonous) effects upon some plants, but most of its value as a weed killer depends upon the fact that it rapidly draws the water out of plant tissues with which it comes in contact. It is more effective, therefore, when applied dry (not as a brine) and also when applied on a dry, hot, sunshiny day.

COPPER SULPHATE

Copper sulphate or blue vitrol has been recommended as a weed killer,[2] and we began these experiments with the idea that it possessed considerable value for this purpose. Three strengths of solution were tried: one

1 True, Am. Assn. Adv. Sci., Proc. 47, p. 410 (1898).

2 Canada Exp. Farms, Bul. 28, p. 9 (1897).

pound in three gallons of water (4% solution); 1 pound in one and one-half gallons of water (8% solution); and one pound in one gallon of water (12% solution). In no case was the result satisfactory. For example, in one plot containing plantain, purslane and various grasses the results following the application of a 5% solution were as follows: At at the end of one week some of the purslane leaves were dead, but no plants entirely killed. The purslane and grass leaves were but slightly affected. At the end of two months most of these plants had recovered their vigor. All our trials agree in showing that copper sulphate is inferior as a weed killer to other chemicals to be mentioned later. It is worthy of note in this connection, however, that copper sulphate may have decided value as a weed-killer under other circumstances. It has been found by recent trials in Europe that a weak solution of this chemical sprayed over a grain field infested with kale may destroy the weed without injuring the grain. H. L. Bolley of the North Dakota experiment station writes that experiments made by him indicate that it is possible to destroy the common annual weeds in a grain field by such use of a 3% solution and that this strength does not injure the grain. In the light of our own experiments we are led to believe it probable that such results as he describes are due to the killing by the solution of the tender upper portions of the weed plants. The grain in its rapid growth would soon overtop and smother the weeds thus weakened.

Further investigations of the practical usefulness of this chemical as a weed killer may therefore be awaited with interest.

KEROSENE

This was used diluted with water in the proportion of one part kerosene to three parts water (25% mixture). When so diluted and applied at the rate of 8 gallons to the square rod it failed to kill the weeds. It became evident, therefore, that the herbicidal activity of the kerosene is so slight in proportion to its cost as to preclude its practical use as a weed killer.

POTASSIUM SULPHIDE (LIVERS OF SULPHUR)

One pound in three gallons of water (4% solution) when applied at the rate of eight gallons per square rod, in one trial was not effective in destroying the weeds. It gave so little promise of practical value that no further trials were made.

CARBOLIC ACID

The crude liquid was added to water in proportions varying in different trials from one pint per gallon (12½% sol.) to one-fifth pint per gallon (2½% sol.). This was mixed with the water by agitation and was applied

in some cases hot, in others cold, at the rate of eight gallons per square rod. The results were generally satisfactory, with solutions stronger than 3%, that is, containing one-fourth pint or more to the gallon of water. This chemical was quicker in its action than was any other under trial. In twelve hours after its application all parts of the weeds above ground were browned and apparently killed. These weeds included plantain, dandelion, chicory, rag-weed and grasses. A week later they appeared the same. Two months later there was evidence of the survival and recovery of some of the plants. The dandelion roots had not been entirely killed and some new shoots were appearing. A large proportion of the grass (quack and Kentucky blue) had likewise thrown up new shoots, and some seedling weeds were growing which had germinated since the application. It was one of the best chemicals used for killing knot-grass.

These results indicate that carbolic acid is a valuable herbicide and very quick in its action, but that it does not penetrate deeply enough into the soil to destroy all of the underground parts of certain weeds and that the herbicidal action is of short duration as compared with some other chemicals. There are two objectionable features associated with the use of carbolic acid. First, its odor. This is strong and to many disagreeable, and renders its use in the immediate vicinity of a house somewhat objectionable. This odor disappears soon after the application is made. Second, the insolublility in water. It is of a heavy, oily nature and does not form a permanent mixture with water. It is necessary, therefore, to agitate it frequently while the application is being made in order to insure uniformity in the distribution.

WHITE ARSENIC AND SAL SODA MIXTURE

This was used in the manner suggested by Shutt,[1] viz: white arsenic, one pound; washing soda, two pounds; water, three to nine gallons. The weaker solution proved strong enough to destroy practically all weeds. The perennial grasses were the only plants which survived the applications and most of them were killed. It was not so quick in its action as was the carbolic acid, but its effects were more enduring. Some plots treated with it in July, 1898, were still practically free from weeds in August, 1899.

There are two objectionable features associated with the use of this mixture. First, the trouble of preparing it; and, second, the fact that it is a deadly poison to animal life. Neither of these is so serious as to preclude its usefulness, but both need to be taken into consideration in estimating its practical merits as compared with other herbicides.

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1 Canada Exp. Farms, Bul. 28, p. 9, (1897).

ARSENIATE OF SODA

This is a chemical which is readily soluble in water. It was chosen as offering for this reason a convenient substitute for the mixture of sal soda and white arsenic. It was used at the rate of one pound in four gallons of water, and also of one pound in eight gallons of water. The latter strength proved sufficient to destroy practically all weeds. It was a little prompter in its action than was the preceding mixture, and, on the whole, was rather more effective. Its persistence in the soil seemed about equal to that of the arsenic and sal soda mixture. The objection holds against this also that it is an active poison to animals. It is also somewhat more expensive than is the white arsenic and sal soda mixture, but for operations on a small scale its greater convenience serves to recommend it for use.

COMMERCIAL WEED KILLERS

In addition to these compounds, trial was made of two commercial weed killers. One of these was obtained from Peter Henderson & Company of New York, under the trade name of Herbicide. It was in the form of a liquid and put up in a one-gallon can. The cost was one dollar a can. The directions were to dilute this with twenty-five gallons of water. It was so diluted and applied like the other solutions, eight gallons to the square rod. It proved very effective, its action being similar to that of the preceding arsenical solutions. It was not as prompt in action as was the carbolic acid, but fully equal to any of the other chemicals tested. At the end of one week practically all the weeds, including the grasses, were apparently dead. At the end of two months these herbicide plots were considerably cleaner than were those treated with carbolic acid, and were in fully as good condition as were those treated with any other chemical under trial.

Chemical examination[1] showed this herbicide to contain much arsenic associated with an alkali. It is apparently very similar in composition to the arsenical solutions already discussed, and is of course open to the same objection as a poison. The cost of the diluted solution is four cents a gallon, which is considerably greater than that of the other arsenical solutions. This greater cost is to be weighed against its greater convenience as compared with some of the others.

Another preparation tested is that known as Smith's Perfect Weed Killer, sent out by Mark Smith, Louth, England. It is put upon the market in two forms. One of these is a concentrated liquid similar to the herbicide just discussed, the other is a dry powder. This latter is said to be the same thing as the liquid in a different form, and was used in our trials diluted with water according to directions. It behaved similarly to the arsenical solutions and the herbicide already discussed. Its action was

1 See chemical analysis, p. 147.

rather slower than these during the first few days, but ultimately the results were practically alike.

COST OF THE VARIOUS CHEMICALS

It is evident from these results that it is possible to kill weeds by the use of chemicals. The practical usefulness of the method depends largely upon the expense. Two elements enter into this, first, the cost of the chemicals; and, second, the frequency with which the application must be repeated. The price of the chemicals will, of course, vary. The Burlington Drug Company recently gave us the following quotations on one hundred pound lots:

Crude carbolic acid, 25 cents a gallon.

Sal soda, 1¼ cents a gallon.

White arsenic, 6½ cents a pound.

Arseniate of soda, 11 cents a pound.

The cost of these as diluted and used in the proportions and amounts indicated in our experiments becomes as follows:

Crude carbolic acid.—1 pint in 4 gallons of water, or 4% solution, ½ cent a gallon or 4 cents a square rod.

Arsenic-sal soda mixture.—Weaker form, 1 cent a gallon or 8 cents a square rod.

Arseniate of soda.—1 pound in 8 gallons of water, 1½ cents a gallon or 11 cents a square rod.

Henderson's herbicide cost us $1.00 for the can, to be diluted to 25 gallons; cost of a gallon as used 4 cents, or 32 cents a square rod.

Smith's weed killer cost in England 43 cents a can (dry form) to be diluted to 25 gallons. Cost for a gallon about 2 cents, or 15 cents a square rod. The cost of the liquid form is practically the same. The duty and cost of carriage must of course be added to these prices. These additions would probably bring the cost of the english article to nearly that of the american.

The frequency with which it may be necessary to repeat the application of these weed killers is not fully decided by our experiments. Apparently, one thorough application each year would be sufficient of either of the arsenical solutions, or of the two proprietary compounds. It is doubtful if one application of carbolic acid would suffice, but two would quite certainly do so. It seems probable also that the effects of many of these arsenical applications will be cumulative owing to the retention of the poison in the soil. These conclusions are borne out by the experience of Prof. Nicholson of the Royal gardens, Kew, England, who writes us that the Smith's Perfect Weed Killer is used in the walks and drives of that institution and that one application yearly suffices.

GENERAL CONCLUSIONS

Gravel walks, drives, tennis courts and similar places can be kept free from weeds by the use of certain chemicals.

Common salt can be used for this purpose, but very heavy applications are required, and when used in such amounts it is liable to be washed into the borders of adjacent lawns. Salt should always be applied in the dry form. The weeds may be more fully suppressed without such danger from washing by certain other chemicals. These are to be applied in solutions, and at the rate of about eight gallons to the square rod.

Crude carbolic acid is a very powerful and quick acting herbicide. One pint in four gallons of water is usually sufficient, cost as diluted, ½ cent for a gallon, 4 cents to the square rod. Its effects are not as enduring, however, as are those of the arsenical solutions.

Various arsenical compounds are available, including arseniate of soda, a mixture of white arsenic and sal soda, and two proprietary articles. The choice between these latter becomes largely a matter of relative expense and convenience. In general, the choice should in our judgement lie beween the crude carbolic acid and the arseniate of soda.

One, or at most, two applications each season of one or another of these chemicals will, it is believed, suffice to keep down the weeds.

REPORT OF THE HORTICULTURIST

F. A. WAUGH

The work of the horticultural department during the year now closing has followed the same lines as heretofore. For reasons elsewhere discussed principal attention has been given to the study of plums. The matters to be reported upon at this time are discussed in the following order:

The pollination of plums.

I. General considerations.
   1. Blossoming seasons.
   2. Mutual affinities.
   3. Amount of pollen produced.
   3. Value of pollenizer as a fruit bearer.

II. Recommended pollenizers.

III. Insects and pollination.

IV. June drop.

Types of European plums in America.

Hybrid plums.

Geography of variation in the genus Prunus in America.

Field notes on cherries.

I. Varieties.
   1. Explanatory statements.
   2. Descriptive, historical and nomenclatural notes.
   3. Memorandum of desirable varieties.

II. Culture.

THE POLLINATION OF PLUMS

I. GENERAL CONSIDERATIONS

"Cross-pollination is advantageous to many varieties of plums, and necessary to at least a few."[1]

"For all practical purposes all classes and varieties of native plums may be regarded as absolutely self-sterile. * * * * The Japanese plums are sometimes quite self-sterile."[2]

1 Vt. Exp. Sta. Bul. 53, p. 50 (1896).

2 Vt. Exp. Sta. Rpt. 10, p. 88 (1897).

"Robinson is self-fertile to some degree, but, as far as our experiments have extended, all other varieties of native and Japanese plums have proved self-sterile."[1]

These are the conclusions reached in three successive reports on the question of self-sterility in plums already issued by this station. These statements will be seen to be in practical agreement. And they are further reinforced by the experiments of another year, only a part of which are reported in the following pages. On the whole the second statement of the case above, quoted from our report of 1897, seems to be most satisfactory: "For all practical purposes all classes and varieties of native plums may be regarded as absolutely self-sterile." The Japanese plums may as well be put into the same category. Much to our regret, our experiments have not been extended to any considerable number of varieties of the Domestica group, and we do not feel at liberty to draw any conclusion as their self-sterility or self-fertility.

Being interpreted the conclusion here reiterated simply means that, while certain varieties of plums in certain locations and at certain times may prove to be self-fertile, such cases are exceptional. In other words, it is the part of wisdom for the practical orchardist to act as though self-sterility were universal amongst the plums.

It may be worth while to explain once more at this point that a certain tree or a certain variety is said to be self-sterile when the pollen of its own blossoms does not fecundate the ovules, or embryonic seeds. When an ovule is not properly fertilized or fecundated the young fruit usually falls off the tree long before maturity. Frequently it never "sets," in the first place. That is, a crop of plums, in many cases if not in most, is dependent on the proper fecundation of the ovules; and this in turn is dependent on cross-pollination in those varieties which are self-sterile. To protect himself against loss from this cause the plum grower has resource to the simple expedient of mixing varieties. Either several varieties are planted in adjacent rows in the orchard, or in special cases, two or three varieties are grafted into the top of the same tree.

Investigation of the subject shows further that this mixing of varieties for cross-pollination should not be made carelessly. Some varieties will pollinate each other, while some will not. The selection of varieties for proper cross-pollination should be controlled by certain general principles. The most important matters to be considered in selecting a pollenizer for a given variety seem to be the following four:

1. Blossoming season.
2. Mutual affinity.
3. Amount of pollen borne.
4. Value of the pollenizer as a fruit-bearer.

[1] Vt. Exp. Sta. Rpt. 11, p. 257 (1898).

The first requirement is absolute. If two varieties do not blossom at the same time they cannot pollinate one another. The second one is very important in some cases. The third is apparently less often of practical consequence. The fourth consideration is not a matter of pollination properly, but is often of more practical importance to the fruit grower than some of the other matters.

1. BLOSSOMING SEASONS OF PLUMS

Early in our experimental work it became evident that the question of blossoming seasons was one of great practical consequence. In our report of two years ago there was presented a blossoming chart[1] showing the relative flowering seasons of 176 varietieties of plums. In our report of a year ago this chart was thoroughly revised, considerably extended, and the principles on which its constructiou and use seem to rest were somewhat fully discussed[2].

The only point of that discussion to which we need revert in connection with the work of the present year is that of the constancy of relative blossoming seasons from year to year. The question is, will a given series of varieties blossom in the same order year after year? To state it differently, we wish to know how accurately we can adjust varieties to one another for purposes of cross-pollination from the blossoming chart. Several comparisons were offered in our last report tending to show that such a chart, if carefully made, might be somewhat closely followed.[3] It will be worth while to present here the experience of another year.

The spring of 1899 was unusual in its meteorological conditions at Denton, Md., where most of our observations have been made. The blossoming season was very late in beginning, owing to continued cold weather. At about the time the earlier varieties came into blossom, however, the weather turned suddenly warm, and a relatively high temperature with bright sunshine prevailed for two weeks or more. The season on the whole was shortened, though retarded at the beginning; and the majority of varieties blossomed as one might say, under pressure. We were interested to note now closely the order of blossoming followed, under these abnormal circumstances, the succession established by six years of previous observation and summarized in our blossoming chart.

In order to make this comparison 20 of the best known varieties were selected at random from those recorded in our blossoming notes of 1899 and

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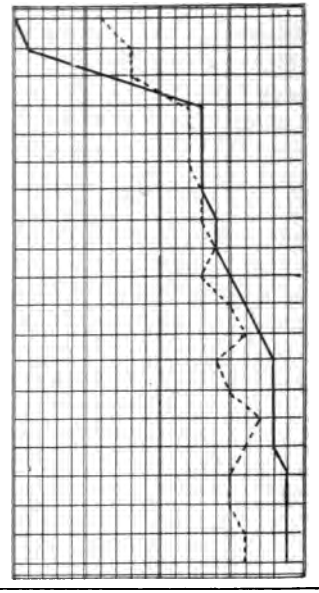
1 Vt. Exp. Sta. Rpt. 10 pp. 94-98 (1897).

2 Vt. Exp. Sta. Rpt. 11, pp. 248-262 (1898). The article in the same report entitled, "A Contribution to the Knowledge of Physiological Constants," pp. 263-272, bears on the same subject.

3 Vt. Exp. Sta. Rpt. 11, pp. 252-267 (1898).

their blossoming seasons platted by the solid line in the accompanying chart. The varieties were arranged in the order of their blossoming. In the chart each vertical line represents one day's time. After this part of the diagram was complete the dates of blossoming for 1899 were indicted on the same plat and the points connected by the dotted line as shown.

COMPARISON OF BLOSSOMING DATES, 1898 AND 1899



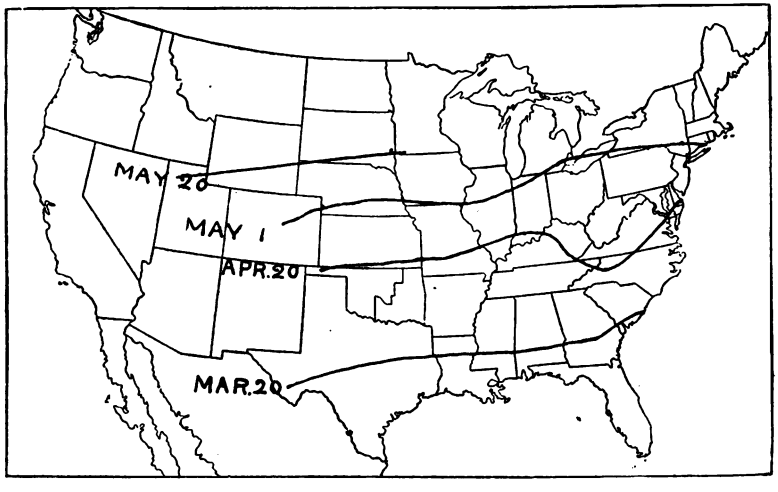
In this diagram the greatest discrepancy is shown in the comparison of Miner and Hammer. It is possible that some local disturbance may have caused a small error in the observed blossoming date of Hammer for 1899, the date here recorded having been taken from a single tree. According to the chart Hammer should blossom one day later than Miner, whereas, according to the note book of 1899, Miner blossomed two days earlier than Hammer. This gives a total difference of three days. Still it will be seen at once that if the two varieties had been placed together for cross-pollination they would have been undoubtedly quite effective this year in spite of this maximum discrepancy.

When we consider the general trend of the two lines in the foregoing diagram, however, their correspondence is striking. The blossoming season of 1899 was shorter than the average season represented by the blossoming chart, but the sequence of varieties was almost the same. With the exception noted there is no divergence of more than one day from the order

established in the blossoming chart. This is a difference less than what might reasonably be charged to "experimental error," or to unavoidable mistakes of field observations.

GEOGRAPHY OF THE BLOSSOMING SEASON

In adjusting varieties of plums to one another so as to mix together those which blossom at the same time additional care is necessary if the blossoming notes used for comparison have been taken at some other place than the one where the new plum orchard is to be planted. Taking the United States over, the blossoming season covers a considerable period. It begins in Florida and Louisiana in February, indeed some of the early flowering Japanese varieties open their blossoms in January. In Georgia and South Carolina the blossoming season is usually at its height about the middle of March. By the first of April it has reached nearly the latitude of Washington ; and it requires still another month for the blossom wave to reach us here in northern New England. All points on the same



ISOPHENAL CHART

Showing the blossoming season of Wildgoose for 1899.

latitude do not have the blooming season at the same time, however. Neither does the blossoming season necessarily follow the isothermal lines. In fact those who have studied this subject most carefully have usually concluded that it never does, unless by accident. The only practicable way, therefore, for us to secure some basis for the comparison of blossoming seasons in different localities is to construct isophenal charts from actual ob servations of blossoming seasons over the territory in question.

A beginning in this direction was made a year ago, and charts were offered showing the blossoming periods of Wildgoose and Burbank for the year 1898. This comparison has now been renewed for another year. Herewith appears a chart showing the blossoming season of Wildgoose for 1899. It will readily be seen that, so far as this variety is concerned, the flowering season does not follow the parallels of latitude, nor yet the isothermal lines. Although the meterological conditions of early spring were much different, all over the United States, in the spring of 1899 from what they were in 1898, there appears to be a general correspondence of the two isophenal charts. At least they show fairly well what the difference of blossoming season is for a given difference of geographical position. Thus, if DeSoto blossoms April 23 at Washington, it may be expected to come into bloom about May 15 in northern Nebraska and central Vermont.

2. MUTUAL AFFINITIES

The problem of the mutual affinities of varieties is one which has interested us greatly from the beginning of our experimental work. At the outset this was thought to be one of the principal problems in plum pollination. In our first publication the following suggestion was hazarded: "It is thought that the botanical relationships of varieties will prove to be the best guide to their affinities in cross-pollination[1]." Continued experiment and extended observation have only partly sustained this view. The opinion held at this writing is that the blossoming seasons are of greater relative importance from the practical standpoint; but that botanical relationships still offer a good key to the affinities of varieties in some cases. It must be said, however, that no one has has yet been able to indicate with great precision the pollination affinities of varieties from their botanical classification.

Some progress has been made, however. A quantity of data has accumulated, especially in connection with the study of hybrid plums and hybridization, and though it does not seem practicable to lumber up this report with a long tabulation of these data which neither the reader nor the writer would understand, it may still be admissible to record briefly those tentative generalizations which present experience seems to justify. They may be summarized as follows:

Japanese group, *Prunus triflora*.—These plums are readily pollinated by the varieties of almost any other group. The least affinity seems to exist between them and the Domestica varieties. They are easily pollinated by

1 Vt. Exp. Sta. Bul. 53, p. 47, (1896).

the Simon plum and by varieties of the Myrobalan or Marianna class, but are especially apt to be pollinated by members of the Chicasaw and Wildgoose groups. This is so much the case that where the Japanese varieties grow mixed with natives of the two groups mentioned, almost every one of the seedlings from the Japanese seed will show decidedly the Chicasaw or Wildgoose characteristics. Ever since the Japanese plums were first studied in this country by Bailey it has been understood that they were closely related botanically to the groups now mentioned as their ready pollenizers.

Chicasaw group, *Prunus angustifolia*.—Many of these varieties are interfertile among themselves, as indeed, seems to be the case within most specific groups. They are also readily pollinated by most varieties of the Wildgoose type, or even by those of the Wayland type, where the latter do not blossom too late. They are usually inter-fertile also with the Japanese plums. Accumulating evidence goes to show that the Chicasaw plums have long been interbreeding with the Americanas in the field, and that the woods are literally full of the resulting hybrids. In fact the whole so-called Hortulana series, including the Wildgoose, Miner and Wayland groups, seems to have no other pedigree. This would of course indicate some considerable degree of affinity between the two groups; but experience in the orchard shows that Americana varieties are seldom the best pollenizers for the Chicasaws, and, vice versa, that the latter are not the most effective with the former. The Chicasaws also blossom earlier than the Americanas in most cases.

Wildgoose group, (probably natural hybrids, *Prunus hortulana* of Bailey).—Many of these varieties are good mutual pollenizers though others are not. For instance, Mr. Kerr's experience has shown that Wildgoose, Whitaker and Milton though blooming simultaneously will not pollinate one another. Sophie will pollinate either, but neither will pollinate Sophie. Varieties of the Miner and Wayland groups are usually entirely effective when agreeing in blossoming season. Japanese varieties often do the work. The best pollenizers, however, seem to be of the Chicasaw group. Newman, for instance, is a remarkably useful companion for all varieties of the Wildgoose group blossoming at the same time. The Americana varieties are sometimes effective, but are not to be chosen as a rule.

Wayland group, (probably natural hybrids, *Prunus rivularis* of Scheele).—On account of the late blossoming of most of these varieties it is difficult to select pollenizers for them from other groups. Such varieties as Miner seem to be satisfactory, however, and the several sorts are generally mutually inter-fertile.

Miner group, (probably natural hybrids, *Prunus hortulana mineri* of Bailey).—These varieties are best pollinated by the Americanas or by other varieties of the same group.

Americana group, *Prunus Americana.*—The sexual affinities of this group with the Chicasaws have already been discussed above. The standing of the Americanas toward the members of the Wildgoose group is much the same. Americana varieties are usually best pollinated by others of the same group or by such sorts as Miner, Maquoketa, or Forestrose, of the Miner group.

3. AMOUNT OF POLLEN PRODUCED

A plum to be a good pollenizer should bear an abundance of pollen. Varieties differ in this respect. The same variety may differ also one year with another, or in one locality as compared with another. Beyond the mere fact that these variations are somewhat common not much is known about this subject. The Chicasaw varieties as a class seem to be good pollen bearers, especially such varieties as Newman, Clark and Pottawattamie. Wildgoose bears abundant pollen under most circumstances, although it is one of the most notably self-sterile varieties in general cultivation. Sophie, on the other hand, belonging to the same group, seems to be deficient in pollen bearing. Some of the hybrid plums just coming into cultivation seem to be especially subject to contabescence, or defectiveness of the male flower organs. Although our knowledge of this subject is seriously limited it ought to be taken into account, as far as it goes, in selecting varieties for cross-pollination.

4. VALUE OF THE POLLENIZER AS A FRUIT BEARER

It is a good thing for a plum tree to bear pollen, but it is still better if the same tree will bear an abundance of good fruit. The practical horticulturist is bound to take this view early into account when selecting pollenizers for his orchard. This, of course, involves the whole question of the selection of varieties, and that is one which can not be taken up here. But this matter, with the others foregoing, has been taken into account in making up the recommendations set forth in the subjoined table of pollenizers.

II. RECOMMENDED POLLENIZERS

It has been the aim in our experiments and publications to elucidate as far as possible those several conditions which control the choice of varieties of plums for effective cross-pollination. All these conditions have to be taken into account at once, however, in making a final selection; and as some of them are still not fully explained, as the several conditions are of different degrees of importance, and as many of the best results of our experiments are felt to be rather matters of personal impression than of categorical fact, it is thought best to summarize the whole matter in a series of brief recommendations. Some folks would rather have the practical fact than the reason for it anyway.

TABLE OF RECOMENDED POLLENIZERS

VARIETY	GROUP	RECOMMENDED POLLENIZERS
Abundance	Japan	Burbank, Red June, Chabot, Satsuma, Georgeson.
African	Chicasaw	Beaty, Newman, Arkansas Lombard.
Aitkin	Nigra	Burbank, Marianna, Cheney.
American Eagle	Americana.	Hawkeye, Speer, Wyant, DeSoto, Miner.
Apricot	"	Stoddard, Wolf, Forest Garden, American Eagle.
Arkansas Lombard.	Chicasaw	Newman, Smiley, Wildgoose.
August	Nigra	Stoddard, Forest Garden, Wolf.
Beaty	Chicasaw	Newman, Wildgoose, Smiley.
Bender	Americana.	Wolf, Forest Garden, Dunlap, Stoddard.
Benson	Wayland	Wayland, Golden Beauty, Kanawha.
Berckmans	Japan	Burbank, Abundance, Chabot.
Blackhawk	Americana.	American Eagle, Hunt, Stoddard, Wolf.
Brill	Myrobalan.	Marianna, DeCaradeuc, Burbank.
Burbank	Japan	Abundance, Chabot, Satsuma, Red June.
Caddo Chief	Chicasaw	Early Red, Marianna.
California	Americana.	American Eagle, DeSoto, Hammer, Miner.
Carver	"	Wolf, Forest Garden, American Eagle, Stoddard.
Chabot	Japan	Burbank, Abundance, Hale, Kelsey, Kerr.
Champion	Americana.	American Eagle, Hammer, Miner, DeSoto.
Cheney	Nigra	Weaver, Gaylord, Forest Garden, Hawkeye, DeSoto.
Cherokee	Americana.	Deepcreek, Colorado Queen, Wildgoose, Smiley.
Choptank	Wildgoose	Wayland, Hollister, Idall, Golden Beauty.
Clara	Americana.	Wyant, Miner, Captain.
Clark	Chicasaw	Newman, Munson, Beaty, Arkansas Lombard.
Clifford	"	Newman, Beaty, Smiley, Arkansas Lombard.
Cluck	"	Wooten, Dunlap, Kroh, Sophie.
Comfort	Americana.	American Eagle, Kopp, Hammer.
Coletta	Chicasaw	Munson, Clark, Newman, African.
Colorado Queen	Americana.	Forest Garden, Wolf, Hilltop, Stoddard.
Comptine	"	Forest Garden, Wolf, Stoddard.
Cook's Choice	"	Stoddard, Forest Garden, Quaker, Kopp, Hammer.
Cottrell	"	Wolf, Forest Garden, Stoddard.
Crescent City	Miner	Miner, Moreman, Prairie Flower, Maquoketa.
Cumberland	Wayland	Whitaker, Indian Chief, Wilder.
Dakota	Americana.	American Eagle, Hawkeye, DeSoto.
Davis	Wildgoose	Wayland, Choptank, Hollister, Golden Beauty.
De Caradeuc	Myrobalan.	Marianna, Abundance, Burbank.
Deepcreek	Americana.	Cherokee, Wildgoose, Smiley.
Des Moines	"	Cherokee, Wildgoose, Smiley.
DeSoto	"	Hawkeye, Weaver, Louisa, Rollingstone.
Downing	Wildgoose	Pottawattamie, Wooten, Cluck, Kroh.
Drouth King	Chicasaw	Beaty, Newman, Hughes.
Dunlap	Wildgoose	James Vick, Kroh, Moreman, Forest Rose.
Early Red	Chicasaw	Caddo Chief, Marianna.
Eldora	Americana.	Miner, Moreman, August, Wolf.
El Paso	Wildgoose	Wildgoose, Smiley, Clifford, Newman.

TABLE OF RECOMMENDED POLLENIZERS

VARIETY	GROUP	RECOMMENDED POLLENIZERS
Emerson	Chicasaw	Munson, Newman, Clark.
Engre	Japan	Marianna, Kerr, Chabot, Ogon.
Esther	Miner	Maquoketa, Iris, Surprise, Stoddard.
Excelsior	Hybrid	Munson, Beaty, Newman, Arkansas Lombard.
Forest Garden	Americana	Stoddard, American Eagle, Kopp, Quaker.
Forest Rose	Miner	Miner, Hammer, Prairie Flower.
Forewattamie	Hybrid	Wayland, Golden Beauty, Choptank.
Freeman	Wildgoose	Pottawattamie, Schley, Wilder, Cumberland.
Galena	Americana	Stoddard, Holt, Iowa, Illinois Ironclad.
Garfield	Wayland	Miner, Forest Rose, Golden Beauty, Missouri Apricot.
Gaylord	Americana	DeSoto, Rollingstone, Cheney, Hawkeye.
Gold (Terry)	"	Stoddard, Forest Garden, Quaker, Late Rollingtone.
Golden	Hybrid	Dunlap, Kroh, James Vick.
Golden Beauty	Wayland	Wayland, Moreman, Kroh, Miner.
Grayson	Americana	DeSoto, Weaver, Hawkeye.
Hale	Japan	Chabot, Kerr, Kelsey, Uchi Beni.
Hammer	Americana	Miner, Moreman, Kopp, American Eagle, Van Deman.
Hanson	"	American Eagle, Stoddard, Forest Garden, Clifford.
Hattie	Myrobalan	Itasca, Purple Yosemite, Munson.
Hawkeye	Americana	DeSoto, Weaver, Cheney, American Eagle.
Heaton	"	American Eagle, Hawkeye, DeSoto.
Hiawatha	"	DeSoto, Hawkeye, Rollingstone, Benson, Williams' 17.
Hilltop	"	DeSoto, Hawkeye, Rollingstone.
Hollister	Wildgoose	Choptank, Wayland, Moreman, Macedonia.
Holt	Americana	Iowa, Peffer Premium, Stoddard, Muncy.
Honey	"	Stoddard, American Eagle, Forest Garden.
Hughes	Chicasaw	Wildgoose, Newman, Smiley, El Paso.
Ida	Americana	Stoddard, American Eagle, Forest Garden.
Idall	Miner	Miner, American Eagle, Wyant, Silas Wilson.
Illinois Ironclad	Americana	Stoddard, Wolf, Forest Garden, Kopp.
Indiana Red	Miner	Miner, Idall, American Eagle, Wyant.
Indian Chief	Wildgoose	Pottawattamie, Wooten, Cumberland.
Iona	Americana	Wolf, Quaker, Stoddard, Forest Garden.
Iowa	"	Stoddard, Hammer, Quaker, Forest Garden.
Irene	"	Stoddard, Hammer, Forest Garden, Quaker.
Iris	Miner	Miner, Hammer, Moreman, Prairie Flower, Forest Rose.
Itasca	Nigra	Wazata, Manitoba 4.
James Vick	Wildgoose	Moreman, Golden Beauty, Dunlap.
Jewell	"	Moreman, Golden Beauty, Dunlap.
Joe Hooker	Americana	Holt, Iowa, Kieth.
Jones Late	"	Kopp, Hammer, Miner, American Eagle.
Juicy	Hybrid	Pottawattamie, Whitaker, Wooten.
Kampeska	Americana	Hammer, Kopp, Miner, Forest Garden, Leonard.
Kanawha	Wayland	Golden Beauty, Moreman, Wayland.
Kelsey	Japanese	Hale, Satsuma, Marianna, Ogon.
Kerr	"	Chabot, Maru, Ogon, Yosebe, Georgeson.

TABLE OF RECOMMENDED POLLENIZERS

VARIETY	GROUP	RECOMMENDED POLLENIZERS
Kickapoo	Americana.	Hawkeye, DeSoto, Wyant, American Eagle.
Kieth	"	Stoddard, Wolf, Forest Garden, Cook's Choice.
Knudson Peach	"	Forest Garden, Hammer, Kopp, Miner.
Kopp	"	Forest Garden, Hammer, American Eagle.
Kroh	Wildgoose.	Cluck, James Vick, Wayland, Golden Beauty.
Large Red Sweet	Americana.	Stoddard, American Eagle, Forest Garden.
Late Rollingstone	"	Gaylord, Wolf, Stoddard, Forest Garden.
Le Duc	"	American Eagle, Hammer, Kopp, Miner.
Leonard	"	Stoddard, Wolf, Forest Garden, Quaker.
Leptune	Wayland	Wayland, Kanawha, Golden Beauty.
Lonestar	Chicasaw	Newman, Wildgoose, Milton.
Louisa	Americana.	DeSoto, Weaver, Hawkeye, Rockford, Rollingstone.
Macedonia	Wildgoose.	Wayland, Dunlap, James Vick.
Mankato	Americana.	Forest Garden, Miner, Hammer, Iona.
Maquoketa	Miner	Miner, Prairie Flower, Surprise.
Marcus	Americana.	Stoddard, Forest Garden, Kopp, Quaker.
Marion	"	Forest Garden, Stoddard, Quaker.
Miller	"	Stoddard, Forest Garden, American Eagle, Kopp.
Milton	Wildgoose.	Newman, Smiley, Clark, Kroh.
Miner	Miner	Hammer, Indian Chief, American Eagle, Forest Rose.
Minnetonka	Americana.	Ocheeda, Rollingstone, Weaver, Speer.
Missouri Apricot	Wayland	Golden Beauty, Wayland, Kanawha.
Moon	Americana.	Forest Garden, Stoddard, Wolf.
Moreman	Wayland	Miner, Wayland, Golden Beauty, Wolf.
Moreman Cherry	"	Wayland, Golden Beauty, Kanawha, Cluck.
Muncy	Americana.	Hawkeye, DeSoto, American Eagle, Wyant.
Munson	Chicasaw	Newman, Clark, Emerson, James Vick.
Nebraska	Miner	Prairie Flower, Iris, Esther, Choptank.
Newman	Chicasaw	Wildgoose, Smiley, Clifford.
Newton Egg	Americana.	Iowa, Stoddard, Forest Garden.
Nimon	Wayland	Miner, Wayland, Golden Beauty.
Normand	Japanese	Burbank, Abundance, Chabot.
North Carolina	Americana.	Kopp, Hammer, Forest Garden, Miner.
Noyes	Miner	Miner, Prairie Flower, Forest Rose.
Ocheeda	Americana.	Minnetonka, Rollingstone, Weaver.
Ohio Prolific	Wildgoose.	Newman, Smiley, Pottawattamie.
Old Gold	Americana.	American Eagle, Hammer, Kopp, Quaker.
Osage	Wildgoose.	El Paso, Pottawattamie, Wooten, Downing.
Pendent	Nigra	Stoddard, Forest Garden, Iowa, Holt.
Penning Peach	Americana.	Holt, Joe Hooker, Stoddard, Wolf, Smith Red.
Peffer Premium	"	Joe Hooker, Holt, Iowa, Marion.
Piram	Chicasaw	Pottawattamie, Wooten, Downing.
Pottawattamie	"	Whitaker, Indian Chief, Wooten.
Prairie Flower	Miner	Miner, Moreman, Rockford, Quaker.
Purple Yosemite	Americana.	Wazata, Itaska, Manitoba 4.
Quaker	"	American Eagle, Kopp, Hammer, Forest Garden.
Rachael	"	Stoddard, Forest Garden, American Eagle.
Rebecca	"	Stoddard, Forest Garden, American Eagle.
Reche	"	Holt, Stoddard, Joe Hooker, Wood.

TABLE OF RECOMMENDED POLLENIZERS

VARIETY	GROUP	RECOMMENDED POLLENIZERS
Red June	Japanese	Burbank, Abundance, Chabot, Satsuma.
Reed	Wayland	Wayland, Golden Beauty, Kanawha, Leptune.
Robinson	Chicasaw	Munson, Coletta, Clark, Newman.
Rockford	Americana	American Eagle, Wyant, DeSoto, Miner.
Rollingstone	"	Weaver, Minnetonka, Winnebago, Moon.
Roulette	Wildgoose	Schley, Pottawattamie, Whitaker, Wooten.
Satsuma	Japanese	Burbank, Abundance, Red June, Chabot.
Schley	Wildgoose	African, Whitaker, Pottawattamie, Wooten.
Seper Peach	Nigra	Forest Garden, August, Stoddard.
Surprise	Miner	Miner, Forest Rose, Prairie Flower, Quaker.
Silas Wilson	Americana	American Eagle, Hammer, Kopp, Quaker.
Sloe	"	Iowa, Holt, Stoddard, Wood.
Smiley	Wildgoose	Wildgoose, Newman, Beaty, Colorado Queen.
Smith Red	Nigra	Marion, Kieth, Iowa, Wood.
Sophie	Wildgoose	Smiley, Cluck, Golden Beauty, Wayland.
Speer	Americana	Weaver, Rollingstone, Cheney.
Stoddard	"	Forest Garden, Quaker, Holt, Hammer.
Strawberry	Watsoni	Newman, Beaty, Arkansas Lombard.
Sucker State	Wayland	Whitaker, Cumberland, Wooten, Miner.
Texas Belle	Chicasaw	Lone Star, Pottawattamie, Milton, Wildgoose.
Van Buren	Americana	American Eagle, Miner, Hawkeye, Champion.
Van Deman	"	Stoddard, Forest Garden, American Eagle, Hammer.
Waraju	"	Holt, Wood, Kieth, Joe Hooker.
Wayland	Wayland	Golden Beauty, Kanawha, Moreman, Miner.
Wazata	Nigra	Itaska, Purple Yosemite, Manitoba 4.
Weaver	Americana	Rollingstone, DeSoto, Louisa, Gaylord.
Whitaker	Wildgoose	Newman, Kroh, Smiley, Sophie.
Wickson	Hybrid	Red June, Burbank, Abundance, Georgeson, Chabot.
Wier Large Red	Miner	Nebraska, Stoddard, Maquoketa.
Wilder	Wildgoose	Pottawattamie, Freeman, Cumberland, Kroh.
Wildgoose	"	Newman, Smiley, Clark, Munson, very good. (Not Miner nor Moreman).
Wildrose	Americana	Stoddard, Forest Garden, American Eagle.
Willard	Japanese	Yosebe, Ogon, Emerson.
Winnebago	Americana	Holt, Stoddard, Wood, Joe Hooker.
Wyant	"	American Eagle, DeSoto, Hawkeye.
Wolf	"	Stoddard, American Eagle, Quaker, Forest Garden.
Wood	"	Stoddard, Wolf, Holt, Iowa.
Wooten	Wildgoose	Pottawattamie, Miner, Whitaker.
Yellow Sweet	Americana	Purple Yosemite, Deepcreek.
Yellow Transparent	Chicasaw	Munson, Newman, Early Red, Clark, Emerson.
Yosebe	Japanese	Ogon, Kerr, Maru.

This series of recommendations can not be guaranteed for all varieties in all localities every year. It undoubtedly contains some mistakes. Any such may be pointed out, to the pleasure of the writer. Meanwhile it is believed that this tabulation represents the best present deductions from the results of scientific experiment plus the observations of practical experience. In general varieties for pollenizers are recommended in the order of their preference. Those recommended are by no means the only ones which might be safely chosen. In most cases the three or four pollenizers named are to be regarded as a suggestion of what might be used, and not as an inflexible prescription of the only sure cure. Only the better known varieties, (omitting altogether those of the Domestica group,) have been named; and these only in so far as we had definite experimental and practical knowledge of them. This table of pollenizers has also been read and revised by Mr. J. W. Kerr, to whom we are under renewed obligations. It would be a pleasure to answer inquiries from plum growers who, not finding here what they want, have the interest to ask for it.

III. INSECTS AND POLLINATION

Early in our experiments in plum pollination, it became evident that it would be desirable to have more exact knowledge of the agencies of pollen distribution. It has long been understood in a loose and hazy sort of way that wind and insects assist in the transfer of pollen from flower to flower and from tree to tree. Experiments were accordingly undertaken to determine the relative importance of these agencies,—to find out how far wind would carry pollen for effective fertilization of blossoms, in what degree insects were necessary, what insects should have the credit of the pollination, what their working habits are, etc., etc. A report was made on this subject last year[1], and the following general conclusions were reached:

(1) Insects are of paramount importance in the pollination of plums.

(2) The common honey bee is much the most useful species in this work.

(3) A few other species are of minor usefulness. These secondary species are mostly small bees, among which the species *Andrena bipunctata* Cr., appeared to be entitled to special notice.

The experiments and observations of another year may now be put on record. They tend to confirm the conclusions of a year ago.

On several trees of sundry varieties clusters of blossoms were covered with coarse mosquito netting or with cheese cloth. The coverings prevented the access of insects to the blossoms, but the mosquito netting, at least, would not prevent the transfer of pollen to and from the blossoms by the wind. The following table shows the result. The approximate number of

1 Vt. Sta. Rpt. 11, p. 245 (1898).

blossoms covered is given. A number of cases are not reported because enough fruit did not set on the trees, outside the coverings, to make a satisfactory check on the experiment.

BLOSSOMS COVERED WITH MOSQUITO NETTING

Variety	Number blossoms	Fruit set	Crop on tree
Wildgoose	50	0	good
"	80	0	"
"	70	0	"
Wolf	35	0	"
"	60	0	"
Kanawha	75	0	medium
Cumberland	70	2	good
Total	440	2	

BLOSSOMS COVERED WITH CHEESE CLOTH

Variety	Number blossoms	Fruit set	Crop on tree
Wildgoose	100	0	full
"	90	0	"
"	125	0	"
"	65	0	"
Total	380	0	

It will be seen that practically no fruit set when the visits of insects were prevented. In the case of Cumberland which set two fruits the circumstances were such as to make it highly probable that certain pistils protruded through the mosquito netting and were reached by bees. At any rate such an accident might have occurred. The bees were often seen alighting on the mosquito netting covers and industriously trying to force an entrance.

It seems fair to conclude from these experiments that insects are necessary to pollination; and that if the wind is ever of any use in this work, it plays a very subordinate part[1].

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1 Consult Lazenby, The relation of honey bees to practical horticulture, Columbus Hort. Soc. Proc. 14, p. 149, (1899). He says that plum flowers are favorites with honey bees.

NOTE—The cheese cloth covering is not considered adapted for this experiment. It probably prevents the access of pollen when brought by the wind. In fact it has been used to replace paper sacks in our self-sterility experiments in certain cases. In such instances it has given the same results as the paper covers. From such facts we have drawn two conclusions on different points: (1) The cheese cloth interferes with the wind distribution of pollen. (2) Inasmuch as the cheese cloth admits an abundance of light and air it does not provide the same "unnatural condition" complained of by some critics of the paper sack method of determining self-sterility. The fact that the results with cheese cloth correspond exactly with those secured under sacks, would furnish another indication that the data secured by the latter method may be relied on. For a full discussion of this subject the reader is referred to the last report (1898), p. 240. An interesting verification of our results has been secured at the Colorado experiment station. See Colo. Sta. Bul. 50, pp. 26-27 (1898).

WHAT INSECTS DO THE WORK?

Last year some observations were made[1] on the insects concerned in pollination. Insects taken from plum trees in blossom in Maryland, New York, Wisconsin and Vermont proved to be of twenty-eight species. Of these, eighteen species were bees and similar insects (hymenoptera), and ten were flies, (diptera). The bees were the most numerous and important, and the common honey bee was by far the most conspicuous of all. This year observations were renewed, and insects were collected in Oklahoma, Maryland, Iowa and Vermont.[2] The following list shows the record of species found this year on plum blossoms at the places named. These species have all been identified for us through the kindness of the entomological division of the United States department of agriculture. The hymenoptera were identified by Mr. W. H. Ashmead and the diptera by Mr. D. W. Coquillett.

LIST OF INSECTS CAPTURED ON PLUM BLOSSOMS. 1899

The X indicates that the species was found at the station named at the head of the column.

	Oklahoma	Maryland	Iowa	Vermont
HYMENOPTERA (Bees and similar insects)				
Apis mellifica Linn, common honey bee,	x	x	x	x
Bombus virginicus Oliv., bumble bee,		x	x	
Andrena vicina Smith,				x
Andrena mariæ Robt.,				x
Andrena bipunctata Cr.,		x	x	
Colletes inæqualis Cr.,	x			
Colletes compacta Cr.,	x			
DIPTERA (Flies)				
Eristalis meigenii Wied.,				x
Eristalis bastardii Macq.,				x
Cynomyia americana Desv.,	x			x
Odontomyia pubescens Day,				x
Scatophaga stercoraria Linn.,				x
Phrobia fusciceps Zett.,	x		x	
Phrobia sp.,	x			
Lucilia cæsar Linn.,	x			
Sarcophaga sp.,	x			

This list numbers only sixteen species, of which seven are bees or their allies, and nine are flies. This is a smaller number than last year, in spite

1 See Vt. Sta. Rpt. 11, p. 247 (1898).

2 Thanks are due to Mr. O. M. Morris for insects collected at Stillwater, Okla., and to Prof. J. Craig for those taken at Ames, Iowa.

of the fact that the flowering season of 1899 was much warmer, brighter and more favorable for the visits of insects. The largest lists collected this year were taken at Stillwater, Okla., and Burlington, Vt., where the weather was distinctly less favorable than at Denton, Md., and at Ames, Iowa. It would be premature to say whether this fact has any significance or not. It should be said at once, however, that, though the number of species represented in the plum orchards of Denton was very small this year, *the actual number of individuals* was far above the average. These were nearly all honey bees.

If we compare the list of species taken in 1899 as given above with the list of those captured in 1898[1] we find very few species common to both. There are only *Apis mellifica*, *Bombus virginicus*, *Andrena vicina* and *Andrena bipunctata*, of the bees and *Odontomyia pubescens* of the flies. Of these only the honey bee, the bumble bee, and the two andrenas occur with sufficient frequency to be of any interest. It seems that various species of andrena visit plum blossoms in greater or less number at different times and in different places. These species are all active and are all pollen bearers so that their visits to the flowers may always have some connection with pollination. Various flies are often seen about the plum blossoms. For instance the two species of eristalis noted were very abundant at Burlington this spring and very persistent in alighting on the blossoms. They do not work into the flowers, however, and they do not carry pollen about with them in quantities as the bees do, so that it may be safely said that they are of no use in the business of pollination.

Observation in the field shows conclusively that the common honey bee is the only insect which ordinarily can be depended on to effect the pollination of plum blossoms[2] in a satisfactory manner. The honey bee persistently *works into* the blossoms, and comes out covered all over with pollen. Large masses of pollen are carried by the bees at all times. They are usually present in comparatively large numbers.[3]

The honey bee is proverbial for his industry, In this respect he has a much greater reputation than he deserves. He seldom begins work before

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1 Vt. Sta. Rpt. 11, p. 247 (1898).

2 Probably the same thing holds true with other fruits which require cross-pollination, such as pears, apples and grapes.

3 Prof. J. Craig, who made the collection for us in Iowa this year, says, however, that pollination was generally satisfactory in the plum orchards in the neighborhood of Ames this spring in spite of the fact that honey bees were very scarce. It may be that a thorough study of all the circumstances would explain this apparent exception.

Compare the statements of Cockerell in New Mex. Sta. Bul. 27, p. 132 (1898). Among other generalizations he says: "The plums which bloom before March 25 are more or less visited by certain flies, the most noticeable of which is *Volucella comstocki*, Williston; but in the main they have to depend on the honey bees, which visit them in myriads."

half past eight in the morning and usually quits at half past four. Even then he knocks off for the smallest shower of rain, or sometimes even for a threatening cloud.

The following note-book entries made in the field, show as accurately as possible the impression made on an observer by the insects as they were at work.

DENTON, Md., April 22, 4 p. m.

Bright, warm, sunny, still weather, with plums in full bloom. Honey bees in great numbers are working diligently on the blossoms. They go directly *into* a bunch of blossoms as soon as they alight. Other insects sit upon the flowers but do not disturb anthers or pistils. There are a few other species about, besides the honey bee, but they are very scarce in comparison, and none of them seems to be of the slightest importance in the business of pollination. Even the bumble bee, which one sees at rare intervals, does not appear to take any interest in the work. It seems safe to say that, so far as insect visits are necessary, the plum blossoms in this orchard are entirely dependent on the honey bees.

BURLINGTON, Vt., May 9, 1 p. m.

Weather very windy; insects working with great difficulty, and not many present. There are several species, however—honey bee, bumble bee, one species of andrena, and several sorts of flies, one or two of which seem to be working the blossoms.

BURLINGTON, May 10, 11 a. m.

Weather still, bright and fine. Many insects are busily at work, but nearly all are honey bees.

NOTE ON SPRAYING

There is a notion current in some parts of Vermont, as well as in other states, that fruit trees ought to be sprayed just at the time when they are in blossom. Some dissatisfaction has been shown by fruit growers, on this account, with a law making it a punishable misdemeanor to spray trees while in blossom. This law was passed at the request of the bee keepers, but it is of even greater importance to the fruit growers, though at their instance it was finally repealed. The observations here reported tend to show more clearly the value of the honey bee to the horticulturist. Furthermore it may be said that spraying when trees are in blossom is entirely useless. It is a waste of time and spraying material; it may be directly injurious to the blossoms; and it may kill the bees. There is everything against it and nothing in its favor. Spray before blossoming, and after the petals fall, but never while the flowers are open.

IV. JUNE DROP

The peculiar phenomenon known as June drop is familiar to all growers of stone fruits. It is always to be observed in some degree with peaches and apricots, but it is of greatest importance with plums.

When the blossoming season is over and the petals have fallen one may see that the flowers have been succeeded by many miniature plums. With rare exceptions there is one of these little fruits to each flower. But it soon becomes apparent that only a part of these will persist. Some of them begin to turn yellow or to wither, and do not increase in size. Others keep bright, fresh and green and grow rapidly. Those of the former class soon fall off, usually within two weeks after the blossoms have gone. This is not the June drop.

This first fall of minute fruits (which sometimes takes the whole crop) is commonly supposed to result from the non-fecundation of the ovules. The flowers are not properly pollinated, the germs of the incipient seeds are not fecundated, and the fruit never enters upon its proper development.

Later in the season another fruit-fall occurs. This commonly comes from three to six weeks after the blossoms have fallen. At this time there is usually a serious depletion of the remaining fruits. Young plums which have begun their development, and which may be from one-eighth to one-half grown, drop from the trees. This occurs in June in middle latitudes, and the phenomenon has therefore come to be generally known among fruit growers as the June drop. It can always be counted on.

The June drop is more or less extensive at different times. It fluctuates with the season, with the variety, with the locality and with various other conditions. Sometimes the crop is so seriously diminished as to leave no fruit for the grower. At other times the thinning is the salvation of the trees. Many varieties of plums set much larger crops than the trees can carry, and unless the fruit is thinned in some way the results are disastrous.

It thus appears that the June drop may be either a source of loss or a direct advantage. In either case an understanding of its causes becomes desirable.

It has sometimes been suggested that the June drop is due to the work of the curculio. One may often observe, however, that many of the drops have not been touched by the curculio, so that the inadequacy of this explanation appears at once. It has also been said that the June drop is due to failures in pollination, but up to the present time this supposition has not been carefully investigated, so far as we know. Attention has been given to this question by this station for the past three years, and brief notes of our observations are herewith submitted.

During the last days of June, 1899, drops were collected from under numbers of plum trees in this neighborhood. Sound plums were taken

from the same trees at the same time, and these were subjected to examination. The following table shows the percentage of fruits in which embryos were found developing. It is thought fair to say that those fruits in which no germs could be found were not fecundated.

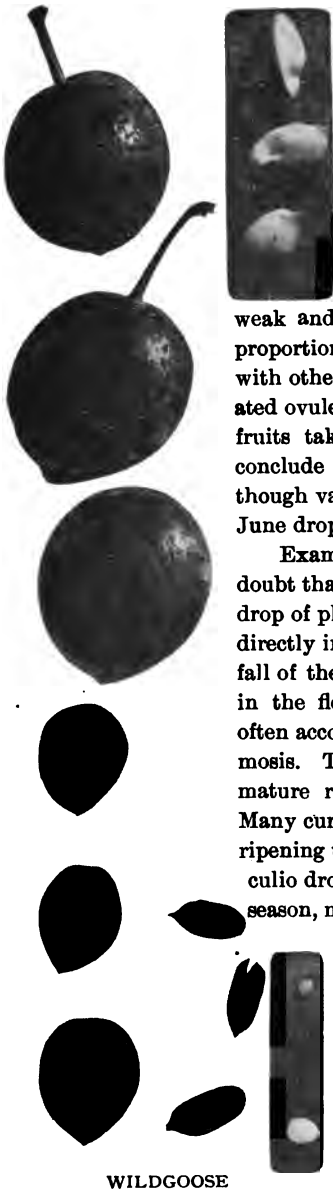
TABLE SHOWING PERCENTAGE OF FRUITS IN WHICH GERMS WERE FOUND

Variety	Drops	Fruits from tree
Abundance	0	70
Burbank	0	80
Burbank (Lot 2)	10	100
Jefferson	40	100
Lombard	80	100
Satsuma	50	70
Shipper	88	100
Willard	0	40
Yellow Egg	100	100
Average	41	84

These results are representative, though conservative. Greater differences between the percentages of germs in drops and in fruits from the trees were found in other cases. Many fruits were examined from several widely separated localities. With the samples reported in the table above, however, 84 per cent of the fruits on the trees seem to have been adequately pollinated, whereas only 41 per cent of the drops were fecundated. The numbers do not represent the difference properly, however, as will be seen from a consultation of the accompanying illustrations. In these it will be observed that the germs from the sound fruit were uniformly larger and fuller than from the drops.

This raises the question whether there may be degrees of fecundation in the plum. Experiments with other species of plants have shown that, within certain limits, larger and finer fruits are produced as a larger amount of pollen is applied in fertilization. So far as the knowledge of the writer extends all these experiments have been made upon plants having several ovules in each ovary. In such cases a number of pollen grains would be necessary to complete fecundation, and it is easily seen how an insufficient amount of pollen might cause incomplete fruit development. The plum, however, except in rare cases, develops but one ovule in each fruit. It is to be supposed—though it is not positively known—that fecundation is effected in each instance by a single pollen grain. This being the case, there would be no such thing as imperfect fertilization. Either a seed is fecundated or it is not.

At the same time it would be possible evidently for a germ to be weak or for the fecundating pollen grain to be weak, or for the fusion of the two



WILDGOOSE

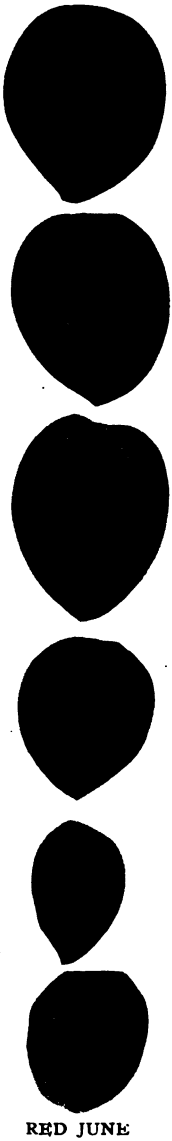
The three plums above were picked from the tree. The three below are June drops. At the right are shown the seeds and the germs; all exact size.

to be in some way imperfect. It seems to the writer that such considerations rather than any differences in degrees of pollination must explain the fact that some plum germs are stronger than others.

Whatever be the reason it is evident from our examinations that some germs are strong and vigorous while others are weak and puny. It is also evident that, though the proportion varies greatly with different varieties and with other circumstances, the percentage of fecundated ovules is much less in the June drops than in fruits taken from the same trees. It seems fair to conclude that pollination plays a considerable, though varying, part as a co-operating cause of the June drop.

Examination of specimens leaves no room for doubt that the curculio is also a factor in the June drop of plums. The curculio larva sometimes works directly into the seed, causing the certain and early fall of the fruit. In other cases the larva works only in the flesh just outside the stone. Such work is often accompanied by external symptoms of gummosis. The fruit usually shows symptoms of premature ripening, and earlier orl ater is apt to fall. Many curculio-infested fruits remain on the tree till ripening time, however. The majority of the curculio drops seem to come toward the end of the season, mostly in July. The non-pollinated drops seem to fall mostly in June.

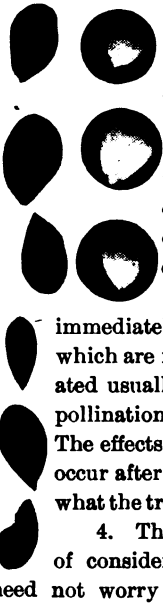
Yet another factor must be considered. Numbers of young plums fall even though well pollinated and though unattacked by the curculio. When plums set too thickly on the fruit spurs and when they are not promptly thinned by other causes, there immediately begins a strenuous struggle for existence. There is not room for all. The strongest only can survive. The weakest are soon robbed of their share of nourishment and are presently literally



crowded off the stems by their jostling brothers. This struggle is severest in the latter part of May and the early part of June and the rejected weaklings figure conspicuously in the June drops. The struggle is less of course as the setting of plums is smaller; and its intensity is influenced more or less by other causes, as food supply, and the operation of the two causes of drops already considered.

CONCLUSIONS

The following generalizations seem to be justified by present knowledge:



1. June drop of plums may be referred to three principal causes. These are: (1) non-pollination, (2) curculio work, (3) the struggle for existence.

2. All these factors vary greatly with circumstances. In some instances one plays the most important part; in other cases another cause has the greatest effect.

3. Leaving aside the drops which immediately follow the falling of the blossoms and which are not June drops, the three causes enumerated usually operate in the following order: non-pollination, struggle for existence, curculio work. The effects of the curculio work are thus apt to occur after other causes have reduced the crop to what the trees could comfortably carry.

4. The plum grower may therefore leave out of consideration the struggle for existence. He need not worry about non-pollination except in those cases of self-sterility and improper adjustment of varieties which would come to his attention without reference to the June drop. He should, however, give serious attention to the curculio, for it is this factor which may oftenest reduce a fair crop to none at all.

RED JUNE

The three plums above were picked from the tree. The three below were June drops. At the right are shown the seeds and germs taken from the same plums. There were no germs in the drops. All exact size.

TYPES OF EUROPEAN PLUMS IN AMERICA

The plums which, up to recent years, have been chiefly cultivated in America are all of European origin. This statement might be slightly qualified by saying that some of them perhaps came originally from western Asia, but all of them have been long grown in Europe, were naturalized there and came thence to America. In recent years the Japanese plums have been introduced into this country, coming here directly from eastern Asia. At the same time several native species of plums have been greatly improved and largely planted in orchards. The plums of European origin have thus come to be of considerably less relative importance, though absolutely they are as abundant and as valuable as ever. Circumstances have conspired, however, to divert attention from them while interest in newer introductions has been unusually, if not unduly excited.

The European plums are still here, however. They are largely grown in certain sections. In fact there are many parts of the country where the native and Japanese species do not seem to flourish. In such places people are compelled to grow the old fashioned varieties or go without.

Our knowledge of the European plums has not kept pace with the general progress of horticultural knowledge in this country. While the Japanese and native plums have been assiduously studied and zealously exploited, our knowledge of the European plums stands practically where it was left by Downing a half century ago. It is evident that some effort ought to be made to bring the botany and the pomology of this class of plums down to date.

TYPES RECOGNIZED IN THE PRODROMUS

Several fairly conspicuous types have been discovered among native plums. Pomologists are generally agreed in speaking of such prominent groups as the Americanas, the Miner group, the Wildgoose group, the Wayland group, the Chickasaws, etc. The question now proposed is, Are there similarly prominent types among the European plums? Or are they inseparably mixed into one specific group?

The botanical history of these plums has already been investigated and paragraphed by the present writer.[1] This history is interesting. It shows that at the beginning of modern botany (the publication of Linnæus' Species Plantarum in 1753) there were several different types recognized among the cultivated plums. Linnæus[2] recorded fourteen. When Seringe wrote the sections on plums for DeCandalle's epoch making botanical work, the Pro-

1 F. A. Waugh, Early botanical views of *Prunus domestica* Linn., Bot. Gaz. 26, p. 417-427 (1898).

2 Species Plantarum, p. 475. (1st ed. 1753.)

dromus, he distinguished nine types[1]. In fact all the best botanical and horticultural students of that day recognized more or fewer well defined groups of the European plums.

As we begin to cast about for a classification suited to the present we naturally turn first to those which were proposed in earlier times. Laying aside the many purely artificial classifications like those of Downing, Thomas, Lauche and others, the most promising exposition of the types of European plums is that given by Seringe, and already mentioned. It will be worth while to review briefly the classification proposed seventy-five years ago and to connect it as far as possible with the pomology of to-day.

The nine types distinguished by Seringe were as follows:

1. *The Mirabelle type.*—(*Prunus domestica maliformis* Linn. Var. *armeniodes* Ser.) This Mirabelle is not the Myrobalan. The true Mirabelle is described by Downing,[2] but his notice is probably largely taken from European literature. The variety is now unknown in America, and there seems to be no other variety representing the group.

2. *The Reine Claude group.*—(*P. domestica cereola* Linn. Var. *claudiana* Ser.) This includes the Green Gage with all its numerous offspring and kin. This is still one of the most prominent and important types. The general character of these varieties has apparently remained unchanged for centuries, and the Reine Claudes of the time of Seringe seem to be very much the same as the Reine Claudes and Green Gages which we know to-day in America.[3]

3. *The Myrobalan group.*—(*P. domestica myrobalan* Linn., Var. *myrobalana* Ser. *P. cerasifera* Ehrh.) Numerous figures and descriptions in the literature of fifty to one hundred years ago show clearly that the Myrobalan of Seringe was the same as the plum now known by that name.

4. *The Damson group.*—(*P. domestica damascena* Linn.) This group is conspicuous and well marked to-day. The propriety at the present day of referring the Damsons to a separate type can hardly be questioned.

5. *The Perdrigon group.*—(*P. domestica pernicona* Linn. Var. *turonensis* Ser.) In Europe this has usually been regarded as a distinct type. There are still several varieties cultivated there under the name of Perdrigon. Some of these were introduced to America in early times and are figured and described in the first American pomological works. None of them is now generally cultivated here, but the type is continued to us in other varieties.

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1 Prodromus, 2, p. 533, (1825).

2 Fruits and Fruit Trees of America, p. 282, (1st Ed. 1845).

3 The history of this group in particular was sketched by the present writer in Gardeners' Chronicle, 3d series, 24, p. 465. (1898).

6. *The St. Julien group.*—(*P. domestica juliana* Linn.) The fruit of the St. Julien plum is small and inferior. The tree has been used chiefly as a stock for grafting other plums. Even in this capacity it is almost unknown in America. As far as we are concerned this type may be considered extinct, unless Professor Bailey's observation be generally true, that the St. Julien belongs to the Myrobalan group.[1] This point cannot now be settled, and need not be since the St. Julien plum is not in cultivation here.

7. *The St. Catherine group.*—(*P. domestica cerea* Linn. Var. *catherinea* Ser.) These plums have been cultivated in America to some extent, the type variety, St. Catherine, being described by Downing[2] and earlier by Prince[3] and Kenrick.[4] I have not seen St. Catherine nor any of the other varieties authoritatively referred to this group; and so far as I am able to understand the type from the fairly ample literature. I am inclined to say that there is no variety in general cultivation in America to-day which may be properly taken to stand for it.

8. *The Dame Aubert group.*—(*P. domestica aubertiana* Ser.) The Dame Aubert which was taken by Seringe as the type of this group is probably the same variety grown to-day as Yellow Egg or Magnun Bonum.

9. *The Prunes.*—(*P. domestica galatentsis* Linn? Var. *pruneauliana* Ser.) For his types of prunes Seringe referred to such varieties as Imperatrice Violette of Duhamel, Zwetschen of Loiseleur-Deslongchamps, and Prune d'Agen of the French nurseries. Plums referable to this type are still abundant and of great commercial importance.

THE MORE CONSPICUOUS MODERN TYPES

In the foregoing review of the old European types it has become clear that certain of them are still with us. Some of them are fairly easy of recognition, and most of them furnish important suggestions toward the better understanding of the present day European plums in America.

Perhaps the easiest way to approach a classification of our varieties grown in America is by excluding first those types which seem to be most conspicuous. Ranged approximately in the order of their distinctness these groups would be as follows:

1. *The Myrobalan group.*—The Myrobalan plum is well known in America as a stock for grafting. Several named varieties are also to be included here, such as Tarleton, Brill, DeCaradeuc, and perhaps Marianna. The Pissard plum, grown largely for ornamental purposes, is probably an

1 See Bot. Gaz. 26, p. 425, (1898).

2 Fr. & Fr. Tr. Am. p. 283, (ed. of 1850).

3 W. R. Prince, Pom. Man. Part II, p. 76, (2d ed. 1832).

4 Wm. Kenrick, New Am. Orchardist, p. 267, (1833).

offshoot from this type. The whole group has been botanically separated from *Prunus domestica* and the name *P. cerasifera* given by Ehrhart[1] in 1789, is used in recent American botanies. In the view of the present writer it might be better to revive the the name originally given by Linnæus[2] viz: *P. domestica myrobalan*, thus making the Myrobalan plum a botanical variety of the Domestica group. Botanical classification is not, however, the matter now in hand and this point need not be further discussed. We need emphasize here only the point that the Myrobalan represents a fairly definite and recognizable type among the European plums.

2. *The Damsons.*—These plums are everywhere sufficiently distinct so that no one will have trouble in recognizing them. They are in fact so well marked with twig and leaf characters sufficiently evident in herbarium specimens, that it would seem proper from the standpoint of classification to recognize them still as a separate botanical variety. Linnæus' name, *Prunus domestica damascena*, could then be used to designate them.

3. *The Reine Claudes.*—The Reine Claude or Green Gage group is readily recognized by pomologists. Many of the most valuable modern varieties belong here. The Reine Claudes come more or less true from seed, and this accounts partially for the persistency of the type and for the large number of varieties representing it. The type is not sufficiently marked, however, to justify us in dignifying it with the rank of a botanical variety. Still it is of sufficient prominence to be used in pomological classification.

4. *The Dame Aubert group.*—The variety now known as Magnum Bonum is probably the same as the Dame Aubert upon which Seringe originally founded this group. Probably Yellow Egg is a synonym of this. Golden Drop (Silver Prune of the Pacific states) also belongs here. The varieties are distinct enough to be referred to a separate pomological group.

5. *The Prunes.*—Horticulturists are now and always have been much at variance as to what should be called a prune. From the standpoint of classification, however, the only proper way to do is to select some type which has certain visible and recognizable characteristics, and to call those varieties prunes which bear a sufficient resemblance to the selected type. The variety which would be best understood and most readily accepted as a type by American pomologists is doubtless Fellenberg, sometimes called Italian Prune. Other varieties which might be commonly accepted as prunes are German Prune, and Prune d'Agen.

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1 Beitrage zur Naturkunde 4, p. 17, (1789). According to the rules of nomenclature followed by some botanists, however, the name of this species would be *Prunus myrobalan* (Linn).

2 Species Plantarum p. 475, (1st ed. 1753).

LESS CONSPICUOUS TYPES

After we leave the prunes there are no types of the European plums generally recognized in America. Still it is evident that the many varieties not referable to the types already mentioned may be reduced to some degree of order, that they are susceptible of more or less classification, and that certain types of minor importance may be selected from among them. The most important of these seem to me to be the following:

1. *The Perdrigons.*—The only variety named by Seringe as belonging to this group and yet in cultivation in this country is Royal Tours. Even this is not common. Goliath and Late Black Orleans (of Ellwanger and Barry) seem to belong here, and are better known in this country.

2. *The Diamond group.*—This includes the blue, hardfleshed, round, elliptical or slightly cordate varieties like Diamond, Kingston and Blue Imperatrice.

3. *The Bradshaw group.*—This includes large obovate or somewhat elliptical varieties having a reddish, purplish, or bluish color, with conspicuous dots, such as Bradshaw, Pond, Field, Victoria, etc.

4. *The Lombard group.*—These are mostly smaller plums, round or round oval and pinkish or purplish.

SUMMARY OF PRESENT DAY TYPES

Those types which seem to be recognizable among the European plums growing to-day in America may be summarized as follows:

Sufficiently distinct to be separated botanically.

1. The Myrobalan group, *Prunus cerasifera* Ehrh., (or *P. domestica myrobalan* Linn.)
2. The Damsons, *P. domestica damascena* Linn.

Major pomological types

3. The Reine Claude type
4. The Dame Aubert type
5. The Prunes

Minor pomological types

6. The Perdrigons
7. The Diamond type
8. The Bradshaw type
9. The Lombard type

CLASSIFICATION OF HORTICULTURAL VARIETIES

The horticultural varieties of the European plums cluster more or less homogeneously about the types just specified. Only in a few cases, though, is it possible to draw clear lines of separation between any two groups.

The groups run into one another; and there are some varieties which can be referred to either of two types with about equal degrees of dissatisfaction.

This fact, that a classification will not absolutely settle the status of every variety, disturbs a good many persons. Because certain varieties cannot be clearly and positively brought into one or another group these persons lose confidence in the entire scheme. This distrust arises from a mistaken view of the proper aims and methods of botanical and horticultural classification. The value of a classification is not measured so much by the sharpness of the demarkation lines which it draws between the groups as by the prominence of the types which it sets forth. It is not so much fencing off varieties by impregnable barriers as it is setting up landmarks to guide the novice amongst the bewildering array of seemingly unrelated forms.

It is thought worth while, however, in connection with the foregoing discussion of types of European plums, to point out the relationship of leading varieties to these types. This amounts to a classification; but the reader must remember that this classification is essayed in the spirit emphasized above.

A very large number of varieties of plums of the class here in review have been named and cultivated in America. Only a small proportion of these are now known to the commercial fruit and nursery trade; very many of them are no longer to be found in the country; and only a fractional part of them have come within the personal study of the writer. Those varieties of which we have made satisfactory notes are herewith arranged with the types to which they seem to belong.

THE MYROBALAN GROUP

Differs from the ordinary Domesticas in having a more slender habit, often thorny; flowers mostly smaller; leaves smaller, thin, smooth and finely and closely serrate; fruit globular and cherry-like, ranging from the size of a large cherry to over an inch in diameter, with a depression about the stem; in various shades of red or yellow.

The american varieties which are to be referred to this group are as follows:

Brill
De Caradenc
Frost proof
Hattie (not typical)
Marianna (perhaps hybridized with some american plum)
Tarleton
Pissard. Sometimes made a separate botanical variety, *P. cerasifera pissardi* (Carr.) Bailey.

THE DAMSONS

Characterized by smaller, shorter-jointed growth as compared with other Domesticas, with leaves smaller, oval, flat, rather sharply dentate; fruit small, oval, sour, clingstone, usually dark blue, but sometimes whitish or yellowish; mostly late ripening. Those which I have examined and which belong here are:

Shropshire
Cluster
Frogmore
White Damson

Bullace. This plum, which is commonly held to represent the species *Prunus insititia* Linn., unquestionably belongs here.[1]

THE REINE CLAUDE GROUP

Foliage usually large, leaves broad and rather flat with very coarse serrations; fruit nearly spherical, in a few varieties slightly elongated, green or tardily turning to a dull creamy yellow, occasionally with a faint pink blush, flesh rather firm or even hard, green, clinging to the stone (partially free in a few varieties). The varieties which I have examined are as follows:[2]

Bavay (Reine Claude)
Green Gage
Lawrence (Favorite)
Imperial Gage
McLaughlin
Jefferson
Washington
General Hand
Lucombe Nonsuch
Bleeker (Bleekers' Gage)
Peters Gage (Peter's Yellow Gage)
Ouillin (Ouillin's Golden)
Bryanstone (Bryanstone Gage)
Golden Gage

THE DAME AUBERT GROUP

Large growing trees, with large foliage; fruit very large, oval, with more or less of a neck; yellow or greenish yellow, or purplish flesh yellow. Here belong:

Magnum Bonum (Yellow Egg)
Coe Golden Drop. (Silver Prune)
Grand Duke

THE PRUNES

Trees and foliage various; fruit mostly medium to large, always oval or ellipsoid, usually with one side of the oval straighter than the other;

1 See F. A. Waugh, "What is *Prunus insititia*?" Bot. Gaz. 27, p. 478 (1899).

2 In general these varieties and those in the following groups are arranged in the order of their conformity to the selected type.

compressed, color blue or purple, flesh mostly greenish yellow, rather firm; stone usually free in a large cavity.[1]

To this group I would refer the following varieties. There are several others which doubtless belong here, but I have not examined them.

Italian Prune	Reine Claude Rouge d'Ete
German Prune	Wangenheim?
Prune d'Agen (Petite Prune)	Churchill?
Datte d'Hongrie	

THE PERDRIGONS

Fruit, medium to large, spherical or oblate, sometimes distinctly depressed at the apex, usually with a deep suture, blue or purple, flesh greenish yellow, rather firm. This group is not so popular in America as in Europe, nor so much grown here now as formerly. The varieties which I have seen are as follows:

Royal Tours	Violette de Galopin
Late Black Orleans	Lafayette?
Goliath	Prince Engelbert??

THE DIAMOND GROUP

Fruit mostly large, oval, very slightly compressed sidewise, dark blue with heavy blue bloom, flesh generally yellow, very firm, usually clinging to the stone. Here apparently belong:

Diamond	Shipper (Shippers' Pride)
Kingston	St. Lawrence
Quackenboss	Arctic (Moore's)
Blue Imperatrice	Gueii?

THE BRADSHAW GROUP

Fruit large, slightly obovate, purplish with distinct pinkish dots, thin skin and juicy flesh. Here belong the following varieties:

Bradshaw	Duane Purple
Victoria	Oswego
Pond	Giant Prune
Field	

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1 In this country, particularly in the Pacific states, a prune is any plum that can be dried and sold as a prune. From the standpoint of classification such a definition can not be accepted. Such an application of the term has never been made in France or Germany where these plums are largely grown. The confusion which arises from the loose use of the term prune is painfully evident, especially to Pacific coast horticulturists; and it seems much better when we speak of prunes to use that word to designate a pomological group rather than a commercial accident.

THE LOMBARD GROUP

Not easily separated from the preceding and perhaps better classified with it. In general the fruit is smaller, oval, very slightly compressed sidewise, pinkish purple, or purplish. The varieties to be classified here are:

Lombard	Leipsic, of Budd
Communia (same as Lombard?)	Prince of Wales
Voronesh 20, of Budd	Merunka

HYBRID PLUMS - SECOND REPORT

I. INTRODUCTORY DISCUSSION

The interest in hybrid plums dates from 1893 when Luther Burbank offered in his "New Creations" the varieties Golden and Juicy, with one or two others not since distributed. Two years later, in 1895, the report of the Pomologist of the United States department of agriculture contained descriptions of the varieties Garnet, Lannix, Monolith, Scribner and Sirocco, grown by J. S. Breece, of North Carolina, and supposed to be of hybrid origin. In the four years since then hybrid varieties have been coming to light in increasing numbers.

A year ago this station, after considerable effort to put itself in command of all the verifiable facts, published the first general discussion of hybrid plums.[1] Since that time new data have been rapidly accumulated, so that it seems proper now to put on record some observations in continuation of the earlier studies. We have notes on a considerable number of new varieties, all of which, with possibly one exception (Occident) have originated from the mixture of two or more accepted species. Sundry notes are added on varieties described in our former paper. Such notes, however, consist only of observations made during the year.

Some space was occupied in our former publication with the discussion of the general aspects of hybridization and hybridism as they appear among the plums. On only one point will further generalization now be offered. This is in the matter of hybrid parentage.

Taking from the new varieties the eighteen of which the parentage is known or may be fairly surmised their origin may be analyzed in the following table.[2]

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1 F. A. Waugh, Hybrid Plums. Vt. Sta. Bul. 67 (1898).

2 In this discussion the names *Prunus hortulana* and *P. rivularis* are used, though it is understood that the groups represented by these names do not properly constitute species in the ordinary acceptation of the term. The name *P hortulana* stands for the Wildgoose and Miner grops and the name *P. rivularis* for the Wayland group.

TABLE SHOWING PARENTAGE OF HYBRIDS

P. americana × *P. triflora*	1	variety.
P. triflora × *P. cerasifera*	2	varieties.
P. triflora × *P. angustifolia*	4	"
P. triflora × *P. hortulana*	1	"
P. triflora × *P. simoni*	3	"
P. hortulana × *A. rivularis*	6	"
P. augustifolia × *P. cearsifera* × *P. triflora* × *P. simoni*	1	"
Total,	18	"

These figures will appear more interesting if examined in connection with the varieties from which they are taken. Attention is therefore directed to the following facts:

1. The Americana–Japanese hybrid is unique. One other reported hybrid of this parentage (Bursoto) given in our former list was there said to be pure Americana. Another reported hybrid of this class raised by Theo. Williams, Nebraska, has not been examined by us.

2. The three Japanese-Simon hybrids are all of Mr. Burbank's introduction. Several others of the same parentage have already been introduced by the same hybridizer.

3. The six Hortulana-Wayland hybrids come also from one man, A. L. Bruce of Texas.

4. Of the four Chicasaw-Japanese hybrids two are contributed by J. S. Breece of North Carolina, one by A. L. Bruce of Texas, and one by W. A. Yates of Texas.

These facts, as far as they go, tend to illustrate and confirm the important observation made a year ago that "hybrid plums seem to go in flocks."[1]

If the parentage of these eighteen varieties be further distributed to the several species which have participated in them the showing is as follows:

Prunus americana	1
P. angustifolia	5
P. hortulana	7
P. rivularis	6
P. cerasifera	3
P. triflora	12
P. simonii	4

In this list three things are worthy of remark: first, the prominence of *P. triflora*; second, the single mention of *P. americana*; third, the conspicuous absence of *P. domestica*.

1 Vt. Sta. Bul. 67, p. 23 (1898).

Following are the year's notes on hybrid varieties.

II. DISCUSSION OF VARIETIES

ALABAMA, (Normand No. 5)

Bailey, Cornell Sta. Bul. 175, p. 154, Nov. 1899

Probably a hybrid of Japanese stock with Wildgoose or Chicasaw. Named by Bailey and described as follows: "Fruit of medium size, round-conical or heart-shaped; color light bright yellow when ripe, with perhaps a faint pinkish cheek, covered with a very thin bloom; flesh soft, sweet and juicy, cling; ripe the 14th of September. The latest of the plums reported in this bulletin. The fruits drop before fully ripe, but developed an excellent quality after they have fallen. On account of its lateness, it is possible that this plum may have commercial value. The habit of the tree is like that of the Georgia."

AMERICA

Burbank, New Creations 1898, p. 3

Waugh, Vt. Sta. Bul. 67 p. 5, 1898

P. triflora × *P. angustifolia*

Additional specimens of this plum were examined this year, confirming in general the opinion already expressed of it. The plum is pretty, but not of large size nor high quality. It partakes very strongly of the Chicasaw parentage. It seems to bear remarkably early. Specimens were received from Texas grown on grafts set in February, 1898.

AMES

Craig, unpublished

P. americana × *P. triflora*

Fruit spherical, size fair, about 33 mm. in diameter, cavity shallow, flaring, stem short, stout, suture very shallow or line, apex very slightly depressed, color bright dark red, dots many, distinct, yellow, bloom thin, blue skin thick and tough, not astringent, flesh yellow, somewhat Miner-like, stone medium large, round, obtusely pointed, flattened, cling, flavor sweet, quality good. Leaves large oval taper-pointed, sharply and somewhat deeply double-serrate, dull glabrous above, finely pubescent on the veins underneath, with two conspicuous glands on the strong short petiole. This variety partakes much more strongly of Americana than of the Japanese characters. Still it shows a pronounced strain of Japanese admixture, especially in shape, color and flavor of fruit. It is very interesting. Originated by J. L. Budd, and will probably be propagated and distributed by J. Craig of the Iowa Agricultural College, at Ames.

APPLE

Burbank, New Creations 1898, p. 2

Waugh, Vt. Sta. Bul. 67 p. 6. 1898

P. triflora, perhaps crossed with some undeterminable species.

This plum partakes most strongly of the character of Satsuma, especially in the hard red flesh, though it is very different in other characters. Still there is no obvious showing of the characters of any other species other than *Prunus triflora*, and this may be merely a pure seedling of Satsuma, or of Satsuma crossed with some other Japanese variety.

The fruit is large and attractive and looks so much like a medium sized apple as to be readily mistaken for one when the apex of the fruit is not visible. The quality is about like that of Satsuma.

BARTLETT

Burbank, in Van Deman, R. N. Y., 57, p. 653. Sept. 1898
Waugh, Vt. Sta. Bul. 67, p. 7. 1898
P. triflora × *P. simonii*

Additional specimens from Mr. Burbank have been examined this year. The plum seems to be of high quality and suited to the amateur. It is a poor shipper, however, and not suitable for market.

BRECK

Ramsey, in Waugh, Vt. Sta. Bul. 67, p. 7. 1898
P. triflora × *P. hortulana*, or possibly with *P. angustifolia*

Fruit oblong or slightly conical, size medium, 40 mm. in diameter, cavity medium deep, rounded, stem very short, suture obsolete, color fine bright red, indistinctly striped, dots many, small, white, inconspicuous, bloom light bluish, skin firm, flesh medium firm, red, stringy, stone medium large, oval, flattened, cling, flavor sprightly, quality good; has much of the Wildgoose character, but is firmer and better colored. The leaves are medium large, rather broadly oval, blunt pointed, abruptly tapering below, margins finely crenulate with many conspicuous small glands, petiole short, usually glandless. Specimens from F. T. Ramsey, Austin, Tex. First offered for sale in Mr. Ramsey's catalogue for fall of 1899.

CAPER

Breece, unpublished
P. triflora × *P. cerasifera*, perhaps

Fruit irregular ovoid, medium size, 40 mm. diameter, cavity shallow, abrupt, suture shallow, color fine dark red, dots many, minute, bloom light colored, skin thick, tough, flesh medium firm, red, stone large; pointed, only slightly flattened, cling, flavor sprightly subacid, quality fair, leaf large, oval, rounded below, pointed above rather thin, smooth, fine double-crenulate, petiole strong and glandular.

Specimens received from the originator, J. S. Breece, North Carolina. Parentage unknown, except that the fruit and foliage suggest *Prunus triflora* and *P. cerasifera*.

CLIMAX

Burbank, R. N. Y. 57 p. 818. Dec. 1898
Royal, of Van Deman, R. N. Y. 57 p. 653. 1898
Waugh, Vt. Sta. Bul. 67 p. 9. 1898
P. triflora × *P. simonii*

Additional specimens received from Mr. Burbank this year seem to justify the high opinion already formed of the variety. Size, color, season quality, and texture commend this plum. It has not yet been fruited outside Mr. Burbank's grounds, however.

COLEUS

Breece, in Waugh, Vt. Sta. Bul. 67 p. 10. 1898
P. triflora × *P. cerasifera*, perhaps

Fruit globular, size small, cavity shallow, abrupt, suture hardly visible, color dark dull deep red, dots hardly visible, bloom bluish, skin thick and tough, flesh medium firm, red, stone small, considerably flattened, cling, flavor flat or a trifle musky, quality poor. Leaf large, broad oval, abruptly acute pointed, rounded at base, double crenulate, dark fine red, conspicuously veined underneath with some pubescence along principal veins.

Specimens from the originator, J. S. Breece. The fruit of this plum is of no value, but the foliage is remarkably fine. It is larger, richer, glossier, more deeply and richly colored than the foliage of any tree of Pissard plum ever seen by the writer. Mr. Breece says that the tree is also a fine grower. It seems probable that this will prove worth propagation as an ornamental plant.

COMPASS CHERRY

Knudson, Minn. Hort. 1896, p. 132
Waugh, Vt. Sta. Bul. 67 p. 10. 1898
P. besseyi × *P. hortulana*

Fruit oval, size 20 x 18 mm., cavity broad, shallow, stem short, strong, suture a faint line, color dark solid red, or finely spotted, dots minute, bloom not seen, skin thick, tough, flesh yellow, rather firm, stone medium size, oblong, somewhat pointed and slightly flattened, cling, flavor rather sour, quality only fair.

Specimens received from J. W. Kerr, Maryland. This plum (or cherry) has received a great deal of attention in certain parts of the west, but does not seem to have any special value.

CORYMBUS

Waugh, unpublished
Parentage doubtful

Fruit heart-shaped, size small to medium, 28 mm. diameter, cavity rather shallow, suture shallow, apex pointed, color dark wine red, dots

invisible, bloom blue, skin strong, flesh soft, yellow, stone small, round, smooth, slightly flattened, cling, flavor rich, sweet, quality extra.

Said to be "Smelt cherry X Abundance." This plum is evidently of the same parentage as Marble though different pedigrees are given by the originator. Both are worth propagating. Both suggest Myrobalan. The probable parentage seems to be *Prunus triflora* × *P. cerasifera.* Received from the originator, A. L. Bruce, Texas, under name of "The Beauty."

CULBERSON

Waugh, unpublished

Parentage the same as Marble

Fruit spherical or slightly pointed, size medium to large 31 x 33 mm., color dark, solid red, dots very many, yellow, bloom bluish, skin very thick and tough, flesh yellow, stone small, round, flattened, cling, quality good to best. A fine plum. From A. L. Bruce, Basin Springs, Tex., under name of Mammoth July. Not yet introduced.

DAISY

Breece, unpublished

P. angustifolia × *P. triflora*

Fruit heart shaped, size medium to large, 43 x 40 mm., cavity shallow, rounded, stem medium, suture obsolete or nearly so, apex pointed, color the finest bright red, dots many, minute, yellow, bloom light bluish, skin thin but firm, flesh firm, yellow, stone large, oval, pointed, flattened, cling, flavor sprightly, Chicasaw-like, quality good. Leaf small, narrow, tapering at both ends, thin, smooth, finely and regularly serrate, petiole slender, slightly glandular.

Specimens from the originator, J. S. Breece, North Carolina. Has strongly the appearance of a Japanese-Chicasaw hybrid, the latter species predominating as usual. It is one of the most beautiful fruits yet seen.

FRANKLIN

Bruce, unpublished

P. triflora × *P. angustifolia*, probably

Fruit oblate, medium size, 33 mm. in diameter, cavity shallow, broad, stem short, strong, suture bright line, color bright crimson over yellow, dots very many, yellow, bloom thin, skin thick and tough, flesh yellow, stone medium size, round, slightly flattened, cling.

Specimens received from the originator, A. L. Bruce, Texas, who calls it "Abundance × Unknown." The fruit looks very much like Golden (page 000), and has probably the same pedigree.

GARNET

Breece, in Heiges, U. S. D. A. Pom. Rpt. 1895 p. 45

Waugh, Vt. Sta. Bul. 67 p. 11. 1898

P. triflora × *P. cerasifera*, perhaps

The history and parentage of this plum are exactly the same as of Coleus. The foliage is much the same, and appears to be the most valuable feature of the variety. The fruit resembles Satsuma in color and flesh, but appears to be of small promise. Season early. Has not been introduced to the trade. Specimens received from Mr. J. S. Breece, who says, "The fruit is quite satisfactory, but too sparingly produced."

GEORGIA (Normand No. 20)

Bailey, Cornell Sta. Bul. 175, p. 153. Nov. 1899

Probably a hybrid of Japanese stock with Wildgoose or Chicasaw.

Named by Bailey and described as follows: "Fruit of medium size but variable, oblong, very blunt or sometimes with a cavity at the apex; color green or light greenish yellow when first ripe but becoming pinkish, with a very thin nearly white bloom; flesh soft, watery, sweet, cling, with a peculiar breaking skin; ripe Aug. 24, some days in advance of the Louisiana. The tree has the habit and fruit of the Louisiana, but that plum is more distinctly heart-shaped. In common with others of these hybrids, Georgia drops when it is still green in color, although it is edible at that time, and a pinkish color appears if it is allowed to lie on the ground. The tree is a spreading, twiggy grower, with slender, glossy, half-zigzag branchlets and foliage suggestive of some of the native plums."

GOLDEN

Burbank, New Creations 1893, p. 17

Gold, of Stark Bros. Catalogue 1896

Waugh, Vt. Sta. Bul. 67, p. 12. 1898

P. triflora × *P. angustifolia*

New material of this variety has been examined this year as follows: Fruit from Burbank, California; Stark Bros., Missouri; Ramsey, Texas; Ellwanger and Barry, New York; growing trees in the orchards of Vermont experiment station, J. W. Kerr, Ellwanger & Barry, New York state experiment station, Cornell experiment station. The fruit is handsome and ships well, but is inclined to ripen unevenly and to drop before ripe. The tree is a good grower, and seems to be comparatively hardy. It stood the winter here in almost perfect condition, though several of the Wildgoose and Wayland varieties suffered considerably.

GOVALLE

Ramsey, Catalogue 1898

Waugh, Vt. Sta. Bul. 67, p. 14. 1898

P. triflora × *P. angustifolia*, probably

Fruit oblong, medium size, cavity shallow, stem short, strong, suture obsolete, color bright red, dots many, fine, white, bloom bluish, skin thin, flesh a trifle soft, stringy, stone medium large, flattened, cling, flavor sprightly subacid, quality good, season early. Leaf medium size, oval, pointed at both ends, thin, light green, very minutely glandular serrate, petiole short.

Specimens received from the introducer, F. T. Ramsey, Texas, who says this is "thought to be a seedling of Kelsey."

GRAYSON

J. S. Kerr, Catalogue, 1898, p. 7

P. hortulana × *P. americana*, perhaps

Fruit irregularly spherical, size medium, 25 mm. diameter, cavity medium deep, suture a line, apex slightly indented, color clear red, dots many, yellow, conspicuous, bloom heavy, white, skin medium thick, flesh yellow, rather soft, stone medium size, oval, slightly flattened, cling, quality good, season after Wildgoose. Leaf large, oval, rough, very finely pubescent underneath, rounded below, tapering above, double crenulate-serrate, petiole glandular.

The twigs and foliage are Americana-like, except the margins of the leaves; the fruit is intermediate between Wildgoose and Wayland. An odd and interesting plum. Received from F. T. Ramsey, Austin, Tex. Mr. J. S. Kerr writes that this is "from seed of Wildgoose probably fertilized with our native wild plum [P. Americana?]" Originated with A. L. Bruce, Basin Springs, Tex., about six years ago.

HALCYON

Breece, unpublished

P. triflora × *P. angustifolia*, probably

Fruit heart shaped, size 38 x 34 mm., cavity deep, rounded, stem stout, suture faint, color bright red, dots few or none, skin thin, flesh yellow, stone large, oval, winged, cling. Leaf medium size, narrow, pointed at both ends, thin and smooth on both sides, minutely crenulate-serrate, petiole with small glands.

Originated with J. S. Breece, North Carolina, who does not regard it highly and who will not propogate it.

LATE CONICAL

Burbank, in Waugh, Vt. Sta. Bul. 67, p. 16. 1898

P. triflora × *P. simonii*

New material from Burbank examined deepens the favorable impression already formed regarding the high quality of this variety. It promises to be valuable on account of its lateness, but does not appear to be a first class shipper. Not yet introduced.

MARBLE

Bruce, unpublished

Fruit heart shaped, small 27 mm. in diameter, cavity medium deep, suture shallow, apex pointed, color dark wine red, dots invisible, bloom blue, skin tough and medium thick, flesh yellow, stone small, oval, slightly flattened, cling, flavor rich and sweet, quality excellent. An odd and very interesting plum of high quality.

Said by the originator, A. L. Bruce of Texas, to be a cross of Weaver with Crimson Beauty; but Mr. Bruce's Weaver seems to be certainly Miner. Crimson Beauty belongs to the Wayland group.

Twenty or thirty other varieties of the same or very similar parentage were received from Mr. Bruce. This one came under name of Fourth of July.

MAYNARD

Burbank, unpublished

P. triflora × *P. simonii?*

Fruit oval, obliquely truncate, large, 51 x 52 mm., cavity medium deep, broad, stem medium length, suture obsolete, color deep dull red, dots very many, minute, bloom thin, whitish, skin thin, flesh yellow, reddening from the outside, meaty, stone medium large, oval, flattened, roughened, perfectly free, flavor rich and sweet, quality extra fine. Named after Prof. S. T. Maynard. A very fine plum.

NONA

Yates, Circular 1897?

P. triflora × *P. angustifolia*, probably

Fruit oval, slightly pointed, size medium, cavity abrupt, stem medium, suture scarcely visible, apex slightly pointed, color dark red slightly striped, dots many, yellow, large and small, bloom light, bluish, skin thick, firm, a trifle bitter, flesh reddish yellow, a little stringy, stone medium size, round, slightly flattened, cling, flavor sprightly sub-acid, quality fine. A good looking early market plum, somewhat the size and form of Wildgoose, but firmer, darker and more pointed.

Specimens received from F. T. Ramsey, Austin, Texas. This plum belongs to the same series as Holland and Yates, described in Vt. Sta. Bul. 67, pp. 14 and 22 respectively. Originated with D. H. Watson, Brenham, Texas.

OLLIE

Bruce, unpublished

"Wayland × Wildgoose," according to Mr. Bruce

Fruit oval, size medium, 28 mm. in diameter, cavity shallow, suture faint line, color dark red, dots invisible, skin rather thin, flesh yellow, with some reddish lines, stone medium size, round, flattened, cling.

Fruit received in poor condition from A. L. Bruce, Basin Springs, Tex. Does not appear to be of value.

PRESIDENT

Waugh, unpublished

P. triflora × *P. simonii* Seedling of Wickson

Fruit heart shaped, large 53 x 53 mm., cavity deep, rounded, stem short, very stout, suture shallow, apex pointed, color dark, fire red, dots many, minute, bloom thin, blue, skin thin, flesh firm, meaty, yellow, stone

large, oval, pointed, flattened, semi-cling, flavor peculiar, a trifle like muskmelon, quality poor to fair in the specimens examined, though said by Mr. Burbank to be much superior to Wichson. Grown by Mr. Burbank, California; named by the author.

PRESLEY

Bruce, unpublished

Probably Miner × Wayland

Fruit slightly oval, medium size, cavity shallow, suture a line, color bright red, dots many, indistinct, bloom thin, skin thick and tough, flesh yellow, stone small, round, flattened, cling, quality good.

Specimens received from A. L. Bruce, Basin Springs, Tex.

RAGLAND

Yates Circular, 1897

Waugh, Vt. Sta. Bul. 67, p. 19. 1898

Fruit oblate, size medium, cavity broad and rounded, stem medium long, strong, suture none, color bright clear yellow, dots many, yellowish, bloom white, skin rather thin, flesh yellow, firm, stone small, round, flattened, cling, flavor sweet and rich, quality extra.

Early and fine, but the yellow color is against it for a market plum. Originated with D. H. Watson, Brenham, Tex.

RAY

Bruce, unpublished

Miner × Wildgoose, perhaps

Fruit oval to spherical, size small to medium, cavity medium deep, suture faint line, color dark red, bloom blue, skin medium thin, flesh yellow, stone small to medium, round, slightly flattened, cling.

Specimens received in poor condition from A. L. Bruce, Basin Springs, Texas. Does not seem to be of value.

RED MAY

J. S. Kerr, Catalogue, 1898

P. triflora × *P. hortulana*

Specimens of this plum have not been examined. The following account is taken from the catalogue of the introducer, J. S. Kerr, Sherman, Texas. "The fruit is larger than that of Wildgoose, oblong, pointed, covered all over with deep red, very similar to Red June in size, color and shape, but five to ten days earlier, more prolific and the tree much more vigorous, according to fair tests in 1896 and 1897; resembling Abundance in growth, blooms rather late, between Botan and Ogon; ripens May 25 to June 10. * * From seed of Abundance fertilized by Wildgoose."

Originated with A. L. Bruce, Basin Springs, Tex.

RUBY

Breece, in Waugh, Vt. Sta. Bul. 67, p. 19. 1898.

P. triflora × *P. hortulana*

Fruit heart-shaped, medium size 38 x 35 mm., cavity shallow, stem short, suture very faint line, apex pointed, color dark, fine, wine red, dots very minute, skin thick, flesh yellow, firm, stone large, oval, pointed, flattened, cling, flavor sweet and rich, quality good. Leaf oval pointed, rather thin but harsh, margin very finely crenulate, petiole subglandular. Partakes strongly of *Prunus triflora* characters. A promising plum. Received from J. S. Breece, Fayetteville, N. C., who writes, "Ruby is quite successful in every way, except its lack of quality." Quality seems to me to be above the average. Not yet introduced.

SATIN

Breece, unpublished

P. hortulana × *P. triflora*

Fruit round oval, size medium, 33 x 32 mm., cavity medium, suture a line, color red, dots many, large, yellow, bloom white, skin thick and very tough, flesh very firm, yellow, stone, medium size, oval, slightly flattened, cling, flavor Americana-like, quality good. Leaf oval, long pointed, thin, green, wholly glabrous, margin finely and evenly serrate, petiole glandular.

Thought to be a hybrid of Moreman and Japanese. Promising. Specimens received from the originator, J. S. Breece of Fayetteville, N. C.

SCRIBNER

Breece, in Heiges, U. S. D. A. Pom. Rpt. 1895. p. 46

Waugh, Vt. Sta. Bul. 67, p. 19. 1898

P. hortulana × *P. triflora*

Fruit oval, large, 45 mm. long, cavity large, rounded, stem short, strong, suture faint line, color dark, fine red, dots many, small, indistinct, bloom heavy, light bluish, skin firm, flesh medium firm, meaty, yellow, stone large, flattened, cling, flavor none, quality extra poor.

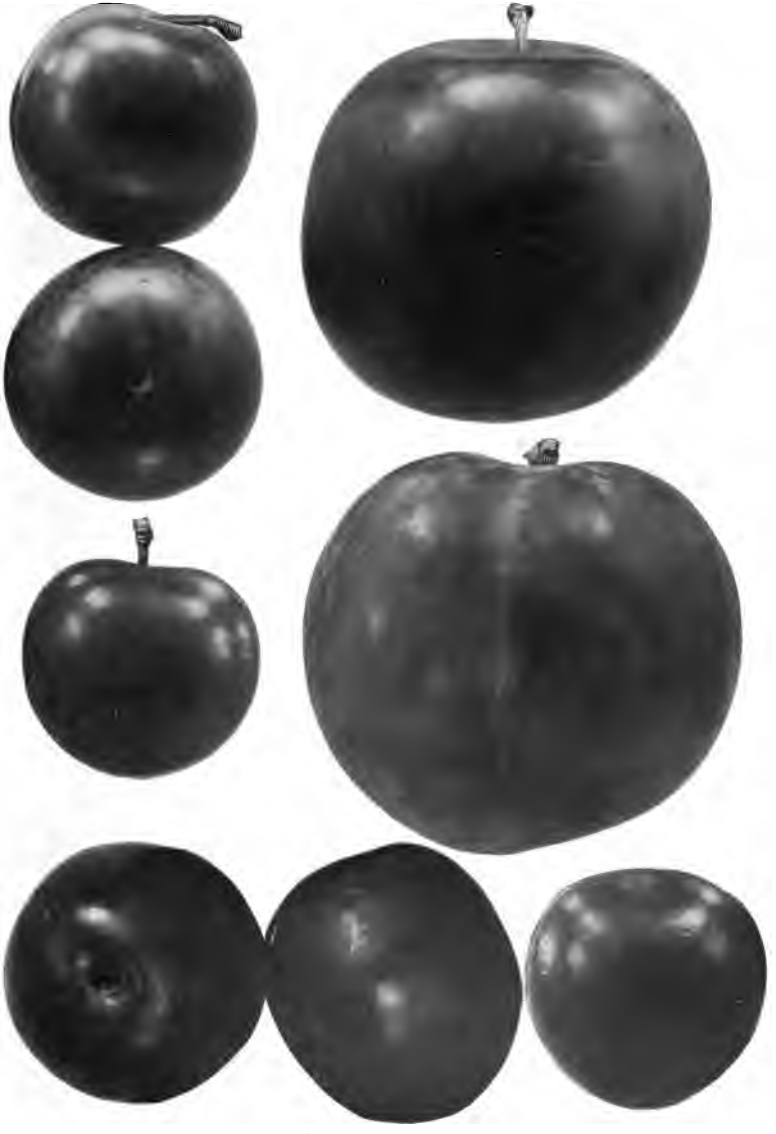
Specimens received from the originator, J. S. Breece, North Carolina, who says, "Not productive, not good quality, rejected."

SHIRO

Burbank, New Creations, 1899, p. 11

P. angustifolia × *P. cerasifera* × *P. triflora* A *P. simonii*, according to Burbank. That is Robinson × Myrobalan × Wickson.

Specimens not seen. Described as bearing "in the utmost profusion, fruit medium to large, very uniform in size, clear light yellow, with an almost imperceptible thin white bloom, and so transparent that the pit can be seen through the flesh, which is firm, yet juicy, rich, pleasant subacid, clingstone, ripens two weeks before Burbank."



NEW HYBRID PLUMS.

Ames (2 specimens)
Franklin
Nona (2)
Maynard
Occident
Culberson

NEW HYBRID PLUMS

Zulu
Vulcan
Ruby
Daisy
Ragland
President

OCCIDENT

Waugh, new name

Sultan of Burbank, New Creations, 1899, p. 8

P. triflora, perhaps crossed with some undeterminable species.

Fruit nearly spherical, very large, 52 x 56 mm., cavity medium deep, stem short, stout, suture shallow, color rather dull red over greenish, dots many, yellow, bloom blue, skin medium thin, flesh dark red, stone medium large, round, turgid, rough, winged, free.

Specimens received from the orginator, Luther Burbank, California. Does not seem to be different in any important particular from Apple, which see, page 220. The name Occident has been substituted for Sultan because the latter was previously occupied. See Downing, Fruits and Fruit Trees, Appendix, p. 157 (1876).

VIRGIE

Bruce, unpublished

Miner × Crimson Beauty, perhaps

Fruit nearly spherical, size medium, 29 mm. diameter, cavity very shallow, suture a line, color deep crimson, dots many, yellow, skin thin, flesh yellow, stone small, round, slightly flattened, cling, quality good.

Belongs to the same series as Marble. Received from the originator, A. L. Bruce, Texas.

VULCAN

Burbank, unpublished

P. triflora × *P. simonii*, probably

Fruit oval, the two halves unequal, very large, 59 x 55 mm., cavity large, abrupt, stem short, very stout, suture deep at top, ends in a line, apex pointed, color purple, shaded into black, dots many, yellow, bloom blue, skin tender, flesh red at outside, shaded to yellow at center, stone large, elliptical, slightly flattened and winged, cling, flavor pleasant, sweet, quality excellent.

Specimens received from the originator, Luther Burbank, California. Parentage not stated, but probably as suggested above.

WICKSON

Burbank, Catalogue 1894

Waugh, Vt. Sta. Bul. 67, p. 21. 1898

P. triflora × *P. simonii*

This plum has been seen growing and fruiting in many different places during the year, and specimens have been received from several sources. It is a beautiful plum, of fair to good quality, and a good shipper. Its defects appear to be a poor habit of growth and shy bearing. It can not be recommended for large planting on the basis of present experience in the east. Mr. Burbank has raised several seedlings of it, one of especial promise

which has been named President, being described in this article, page 226. It is generally reported to be satisfactorily hardy, but strong young trees in the orchards of the Vermont experiment station killed to the ground last winter.

ZULU

Burbank, unpublished

Parentage indeterminable

Fruit round or somewhat oblate, size medium, cavity broad, open, stem short, strong, suture shallow, color very dark dull red, almost black, dots many, minute, whitish, bloom blue, skin thin and tender, flesh firm, juicy, red, stone medium large, rounded, only slightly flattened, cling, flavor rich and sweet, quality good to best. Leaf large oval, abruptly acute pointed, margin coarsely double crenulate. An early plum of high quality, but not so promising as a shipping or market variety. Produced by Luther Burbank, who says regarding its parentage, "It is a mystery, being three or four generations from innumerable crosses, and resembles no other known species or variety."

NOTE—In our former publication on hybrid plums (Bulletin 67) several varieties were discussed which are not noted further in the foregoing article. The varieties formerly mentioned, but not included here are named in the following list. Not quite all of them are hybrids; a few are discussed there merely because they had been supposed to be hybrids.

A—248, Burbank
Alhambra, Burbank
Allfruit, Burbank
Bestovall, Munson
Blackman, Van Deman
Breck, Ramsey
Bursoto, Williams
Cel, Burbank
Chalco, Burbank
Chicrigland, Munson
Daniel Weeping, Normand
Excelsior, Taber
Forewattawie, Williams
Gonzales, Ramsey
Holland, Yates
Juicy, Burbank
Kelsey hybrids, Williams
K. P. 193, Burbank
Lannix, Breece
Louisiana, Bailey
Mankato, Richardson
Marianna
Minnie, Breece
Monolith, Breece
Mule, Kerr
Nikko, Burbank
Pendent, Williams
Pennock, Pennock
Preserver, Yates
Sirocco, Breece
Sophie, Kerr
Utah Hybrid, Johnson
Watson, Yates
Yates, Yates

GEOGRAPHY OF VARIATION IN THE GENUS PRUNUS IN AMERICA

Various circumstances have led the horticultural department of this station to give special attention to the study of plums. This study has covered a wide range. Beginning with the practical problems of plum pollination, the work was soon necessarily extended to the classification of the cultivated varieties. This immediately involved all the questions of botanical relationship, delimitation of species, and nomenclature. Horticultural study of the cultivated varieties and botanical study of the original species have gone hand in hand. Various contributions have been made to both departments of knowledge, though not so often to the latter as to the former.

During the progress of this work, as our notes became more full and our knowledge of the subject more intimate, it has been increasingly clear that no account yet given of the plums exhibits their natural interrelationships in a satisfactory manner. It seems to us important from the standpoints both of horticulture and of botany, to make these relationships clearer. For various reasons it has appeared best to publish here some sketch of the views at which we have arrived.

This essay does not purport to be a revision of the American species of Prunus. It is a brief study of the principal native species, designed particularly to develop three points, as follows:

First, the striking parallelism of modification which obtains in the several species-series.

Second, the relation of these modifications to geographical distribution.

Third, the application of a uniform system of nomenclature to the genus, which shall exhibit the several groups in their proper relationships and with due perspective.[1]

THE AMERICANA SERIES

The idea at which we are aiming will appear clear at once when we take a concrete example in the great Americana series of plums. This is the predominating and most characteristic group of plums on the continent. The typical *Prunus americana* of Marshall, which gives us our hundreds of horticultural varieties of the Americana group, has a wide range. The general trend of this range may be traced by an arc beginning in lower

1 As will be seen, this discussion covers only the principal species of the sections *Prunus* and *Padus* of the genus *Prunus*. This partial treatment is excused on the ground that a revision of the genus is not attempted, and that the chief intention has been rather to demonstrate the peculiar law of geographical modification which seems to prevail in this genus in North America.

Ontario and passing southwestward through southern Michigan, northern Indiana and Illinois, the corner of Iowa, Missouri, Kansas, Oklahoma and and Texas, about to the mexican line.

The Americana series is not discontinued in Ontario, however. There are plums of the same general character growing wild through New York, Vermont, Quebec, New Hampshire, Maine and New Brunswick. Let it be repeated, there is no break in the series. In the neighborhood of lower Ontario and western New York, however, these plums begin to show larger, pinker blossoms, more glandular calyx lobes, broader leaves and more often glandular petioles. The trees growing at Ithaca, N. Y., would be referred by many contemporary botanists to Aiton's species name, *Prunus nigra*. As we proceed eastward the characters of difference indicated above become more and more pronounced, till when we reach Vermont, one can see a striking difference between the native plums and those of Nebraska.

If we examine the southern range of the Americana series we find a very similar transformation. In Texas along the mexican border on the Rio Grande, the leaves and pedicels tend to be much more pubescent. The leaves and calyx lobes are no longer glandular, but the latter are strongly pubescent inside. This form of the Americana plum has been called *Prunus americana mollis* Torr. & Gr.

We have developed here an important fact, namely: The Americana series of plums is *continuous* from New Brunswick to the mexican border. There is no break either in the *geographical distribution* or in the gradual *morphological modification* of the series.

Now in the opinion of the writer this great series ought to stand as one thing, as the Americana series, or as the Americana species. The great central type should be designated by Humphrey Marshall's name, *Prunus americana*; and the subsidary eastern and southern types ought to receive secondary names which shall show their relationship to the central type. This relationship is indicated by the name *P. americana mollis*, and may be similarly suggested for the northeastern extension of the series by using the name *P. americana nigra*. This name was suggested three years ago for this very reason. If the name is written *Prunus nigra* two objections arise; first, the Nigra type is given the same prominence as the Americana type, which it does not merit; second, the close relationship of the two is obscured. The classification loses in perspective and in clearness.[1]

THE CHICASAW SERIES

The Chicasaw plum, *Prunus angustifolia*, Marsh., stands second in importance among the species-groups of North America. This series shows

1 The writer is aware that these considerations do not control in matters of nomenclature. They should, however, be paramount in classification, which is a different and a more important matter.

comparatively little variation; yet at its western extremity the trees become dwarfer, with more spinescent, zig-zag twigs and smaller leaves and flowers. This is the Sand plum, a form to which Sargent gave the name *Prunus watsoni*.[1] It is, however, very closely related to *Prunus angustifolia*, and will be better understood when called a variety of that species,—a change suggested in the appended summary.[2]

THE HORTULANA SERIES

The Hortulana plums, once regarded as a separate species, are now looked upon as a great congeries of hybrids.[3] This great series of hybrids, however, presents certain prominent types, insomuch that each of the principal groups has been given, at one time or another, a separate botanical name. These groups are notably variable, as might naturally be expected of miscellaneous hybrids; and they run into each other in the most puzzling and intricate manner. They also run imperceptibly into all the related species. The Miner group grades into the northwestern form of *Prunus americana;* the Wayland group grades into the southern form of the same species; and the Wildgoose group runs into *P. angustifolia* so connectedly as to leave not the slightest break between them. Certain specimens of the Hortulana series also show so many resemblances to *P. maritima* (particularly to the form discussed here as *P. injucunda*) that their disposition is extremely doubtful.

The Hortulana series has been divided into three pomological groups, corresponding to the three botanical divisions formerly proposed. These are called respectively the Miner, the Wayland and the Wildgoose groups. These groups moreover stand in a definite geographical relation to one another, though each group is geographically intermerged with its neighbors rather more than is the case with most of the other series. The Miner group appears first at the northern extremity of the general range, in the upper Mississippi valley. Next below this comes the Wildgoose group, which is most conspicuous in Missouri. Lastly at the south follows the Wayland group, which, though occurring in Kentucky, Tennessee, Missouri and other central southern states, comes to its typical and most prominent development in Texas.

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1 Sargent, Gard. and For. 7, p. 194 (1894).

2 It may be of interest to note that Bailey contemplated a similar disposition of the Sand plum, but was anticipated in publication by Sargent. See Cornell Sta. Bul. 70, p. 363 (1894).

3 See Bailey Bot. Gaz. p. 462 (1896); also Evolution of our native fruits, p. 197 (1898). Also Waugh, Vt. Sta. Rpt. 10, p. 104 (1897); Garden and Forest 10, p. 340 (1897); Vt. Sta. Bul. 67, p. 22 (1898).

The geographic relation of this series and of its three members to the distribution of the Americana and the Chicasaw series is also a matter of considerable interest, but it need not be discussed here.

THE MARITIMA SERIES

The Beach plum is little known in cultivation at present; but it has many qualities which recommend it to the horticulturist and it will doubtless sooner or later find its way into American pomology, either through the selection of suitable varieties, or though hybridization with other species. It is one of the most variable of all our plums, and our plums are all variable. Several forms, differing considerably from one another, may easily be picked out of any moderate lot of specimens. I have recently examined a large quantity of herbarium material of *Prunus maritima* and related species,—probably a large majority of all the material in public herbaria in the United States,[1]—and I find five types fairly conspicuous. These are as follows, arranged in the order of their apparent prominence:

1. *The type form*, or what appears to be the central, prominent type of *Prunus maritima*. Leaves comparatively large, broad oval, rather abruptly pointed, slightly grayish, tomentose.

2. *The small leaved form.*—Leaves much smaller, an inch long or less, round oval, rounded or abruptly narrowed below, rounded or very obtuse pointed above, rather thick and stiff, pubescence slight or wanting, leaves crowded on short-jointed, dwarfish stem. This form I know only from herbarium specimens. These specimens are very striking, however, and if this form should be found growing in reasonable quantity—as I am told it does—it ought to be described as a separate variety.

3. *The taper-pointed form.*—Leaves thin and green or sometimes slightly grayish below, glabrous or nearly so, narrow oval, tapering at both ends, acute pointed, young growth glabrous or glabrescent. A specially interesting specimen of this collected at Tottenville, Staten Island, in 1897 by A. A. Tyler, is in the National herbarium. This specimen is indistinguishable from Sargent's specimens of *Prunus injucunda* Small, collected at the base of Stone Mt., Georgia. In fact all the material of *P. injucunda* examined, including Dr. Small's co-types and the specimens of Earle & Baker, (Alabama biological survey Nos. 1573 and 1574) seems to be easily referable to this type of *P. maritima*. Not having seen *P. injucunda* growing in the field, I hesitate to remove it from specific rank; but I am strongly of the opinion that it is at most to be considered a variety of *P. maritima*.

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1 We are under special obligations to Prof. L. H. Bailey, Dr. F. V. Coville, Prof. C. S. Sargent, Dr. Wm. Trelease, and Dr. M. A. Howe, for the privilege of examining material in the herbaria of Cornell university horticultural department, U. S. national herbarium, Arnold arboretum, Missouri botanical garden and Columbia university. We have also some material of this group in the herbarium of the Vermont experiment station.

4. *The tomentose form.*—Leaves thicker, and harsher, with more prominent ribs and heavy gray or brownish tomentum.

5. *The glabrous form.*—Leaves of the same form and size as in 1, but thin and glabrous, green above, sometimes gray underneath.

Forms 2 and 3 seem to be worthy of varietal rank. Forms 4 and 5 are of minor consequence, except as they indicate the wide variability of the species.

Prunus maritima is distributed along the Atlantic coast from New Brunswick to Virginia.[1] As has been pointed out by Watson and Coulter,[2] "it varies, when at some distance from the coast (New Jersey and southward), with leaves smoother, thinner and the fruit smaller." This seems to be the form numbered 2 above; and which is now known, under the name of *P. injucunda*, to reach through Georgia to Auburn, Alabama. We are thus able to trace the series practically unbroken from New Brunswick to Alabama. In this region the variations become very confusing. It is sometimes very difficult to separate these variants from certain forms of the Hortulana series[3].

From the neighborhood of Georgia the series seems to extend westward, represented by *Prunus gracilis* Engelm. & Gray. In so far as these two species are now known, *P. gracilis* does not merge into *P. maritima* (or *P. injucunda*), either geographically or morphologically, in the same unbroken manner as do the various forms of the Americana and the Chicasaw series. Nevertheless the two species are evidently closely related, both as regards distribution and as regards external characters.

To the south and west of *Prunus gracilis*, in Texas, another species seems to continue the same series. This is *P. glandulosa* Torr. and Gr. Comparisons of this with *P. gracilis* will reveal many points of resemblance. The characters of difference, moreover, are those which would naturally accompany distribution to a warmer, dryer climate, such as dwarfer habit, smaller, thicker leaves, with more thick tomentum, more spinescent branchlets, etc.

Prunus gravesii Small, seems to belong to the Maritima series also, but is yet too little understood to be satisfactorily placed.

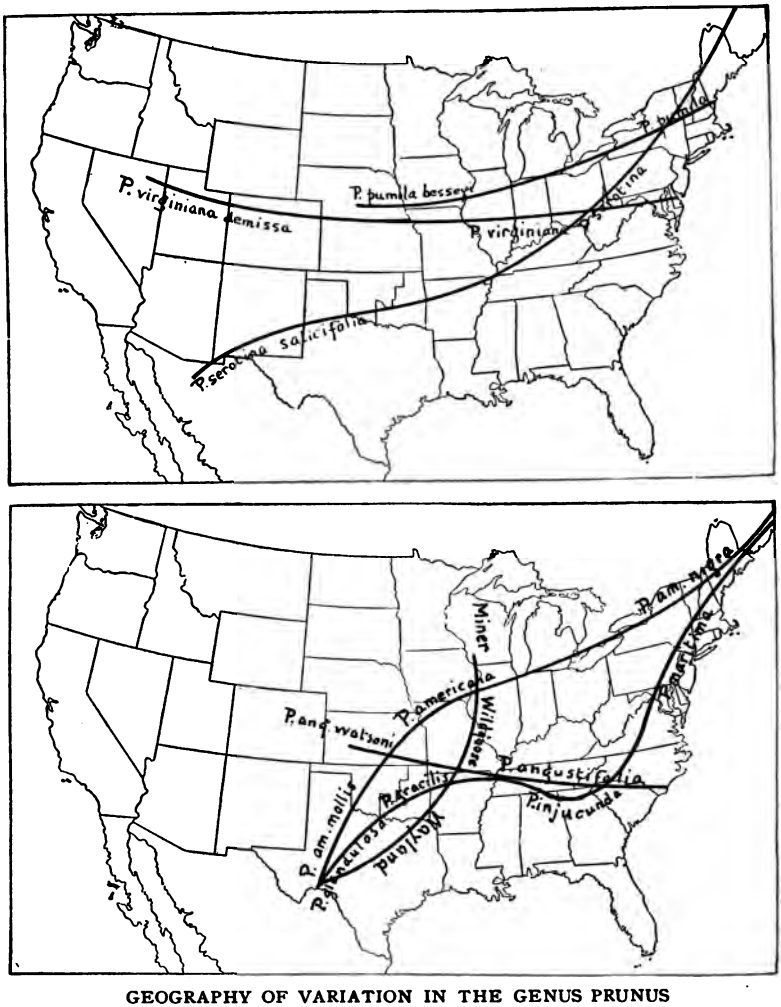
THE SAND CHERRY SERIES

As at present designated there are two species of so called Sand cherries in North America. These are *Prunus pumila* Linn., and *P. besseyi* Bailey. The two are entirely inseparable, however, though in extreme forms *P.*

1 It also occurs over a small detached area at the head of Lake Michigan.

2 Gray's Manual of Botany, 6th ed. p. 151 (1889).

3 See for instance, Mohr, in Torr. Bot. Cl. Bul. 26, p. 118 (1899).



GEOGRAPHY OF VARIATION IN THE GENUS PRUNUS

Map showing the general trend of distribution of the several species-series

besseyi is readily "distinguished by the following characters: * * * Leaves elliptical or elliptic-oblong, much broader and thicker than in *P. pumila*, with more appressed teeth; * * * * fruit nearly twice larger than that of *P. pumila*, on shorter, thicker peduncles." The two seem to be morphologically and geographically continuous, and to form an unbroken series from New Brunswick to Nebraska. The two are so closely related, so impossible of separation, and *P. besseyi* is so clearly a western form of *P. pumila*,

that it seems worth while to combine them thus in one series and to show their relationship by calling the western group a variety of the more prominent eastern form, as suggested on page 239.

THE CHOKE CHERRY SERIES

The western choke cherry of the Rocky Mountains and westward is evidently very closely related to the choke cherry of the east. Its standing with reference to the eastern form has been variously judged by different botanists. Some have called it a district species, and have assigned to it Walpers' name, *Prunus demissa*. Some have said that it is not separable from the eastern choke cherry, and that it should be combined with the latter and take the latter's name, *P. virginiana* Linn. Torrey, however, sought to show the closeness of relationship while still pointing out the characters of difference, and he called the western form *P. virginiana demissa*[1] This last disposition has much to commend it. As it agrees with the method of nomenclature here advocated this name is adopted in the appended summary.

THE BLACK CHERRY SERIES

This series is apparently composed of two members very much like those of the preceding series. The northeastern and dominant member is *Prunus serotina* Ehrh. This is the well-known black cherry, which ranges from Nova Scotia to Florida and southwestward into Arkansas and the Indian Territory, and perhaps even into northeastern Texas. It attains its maximum development in the forests of eastern Kentucky.

Southwestward from the range indicated above the black cherry shows considerably different characters. The leaves tend to be more narrowly lanceolate, and are generally more leathery, smooth and shining. This form has usually been considered a separate species, and several names have been given to it, the oldest name being *Prunus salicifolia* H. B. K. However Sargent says of this form:[2] "It is impossible to find essential characters to distinguish it from the northern species with which it is connected geographically through Arizona, New Mexico and Texas."

We are met, therefore, by the same condition which we have found in the other series already studied. It seems desirable, then, in putting the nomenclature of this genus on a uniform basis, to give this southwestern form of the black cherry series the same treatment that we have given the western member of the choke cherry series. In the subjoined summary it is therefore made a variety of *P. serotina*.

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1 Torrey, Bot. Wilkes' Exped. p. 284, (1854).

2 C. S. Sargent, Sylva N. A. 4, p. 46, (1892).

The southern forms of this series, however, are mentionably diverse. The rather abundant herbarium material which I have consulted shows at least three forms. These are as follows:

1. *The willow-leaved form*, which I take to be the principal one, although form 2 occurs almost as frequently in our herbaria. This is evidently what is described by Humboldt, Bonpland and Kunth as *Prunus salicifolia*.

2. *The broad-leaved form*, which, curiously enough, has leaves broader than in the typical *P. serotina*, thicker, stiffer, more leathery, and usually strongly whitish underneath. This seems to be the same form which Dr. Mohr has recently found in Alabama and described with the name *Prunus alabamensis*.[1]

3. *The acute-leaved form*, (*P. salicifolia acutifolia* Watson, Am. Acad. Proc. 22, p. 411, 1887). In this form the leaves appear to be much like those in number 2 above, but smaller, and generally more abruptly acute-pointed. Forms 2 and 3 might be consolidated without great confusion, though they certainly present different lines of variation.

It will be seen that in the discussion given in the accompanying text only form 1 is considered. There is not at hand enough material to settle the standing of the others. The following questions are left unanswered: Are forms 2 and 3 best understood when consolidated or when separated? If separated, in what relation do they stand to each other and to the type of *P. serotina*? Where does *P. alabamensis* Mohr belong?

SYSTEMATIC SUMMARY

In the following paragraphs the various series, species, and varieties which have been discussed in the foregoing pages are summarized, and the preferred botanical names are given, with the principal synonymy. In the preferred names certain changes are suggested, which, as set forth in the preceding discussion, seem to help toward putting the nomenclature of the genus *Prunus* on a more nearly uniform basis, and to show more clearly the important natural relations existing between the various members of the several series.

Genus PRUNUS

THE AMERICANA SERIES

P. AMERICANA Marsh., Arb. Amer. 111 (1785)

P. AMERICANA NIGRA (Ait.) Waugh, Vt. Sta. Bul. 53:58 (1896)

P. nigra Ait., Hort. Kew. ed. 1, 2:165 (1789)

P. americana Torrey & Gray, Fl. N. A. 1:407 (1840) in part

P. AMERICANA MOLLIS Torrey & Gray, Fl. N. A. 1:407 (1840)

P. americana lanata Sudw., Nom. Arb. Fl. U. S., 237 (1897)

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1 See Torr. Bot. Bul. 26, p. 118 (1899).

THE CHICASAW SERIES

P. ANGUSTIFOLIA Marsh., Arb. Amer. 111 (1785)
P. chicasa Michx., Fl. Bor. Am. 1:234 (1803)
P. ANGUSTIFOLIA WATSONI (Sarg.) comb. nov.
P. watsoni Sarg., Gard. & For. 7:194 (1894)

THE HORTULANA SERIES *Hybrids*

THE WILDGOOSE GROUP, Bailey, Cornell Sta. Bul. 38:16 (1892)
P. hortulana Bailey, Gard. & For. 5:90 (1892)
THE WAYLAND GROUP, Waugh, Vt. Sta. Rpt. 10:103 (1897)
P. rivularis Scheele, Linnæa 21:594 (1848)
P. hortulana Bailey, Gard. & For. 5:90 (1892) in part
THE MINER GROUP, Bailey, Cornell Sta. Bul. 38:23 (1892)
P. hortulana mineri Bailey, Cornell Sta. Bul. 38: 23 (1892)

THE MARITIMA SERIES

P. MARITIMA Wang., Amer. 103 (1781)
(a) Small leaved form
(b) Taper-leaved form
P. injucunda Small? Torr. Bot. Club Bul. 25:149 (1898)
P. GRACILIS Engelm. & Gr., Bost. Jour. Nat. Hist. 5:243 (1847)
P. GLANDULOSA, Torrey & Gray. Fl. N. A. 1:408 (1840)

THE SAND CHERRY SERIES

P. PUMILA Linn.
P. PUMILA BESSEYI (Bailey) comb. nov.
P. besseyi Bailey, Cornell Sta. Bul. 70:261 (1894)

THE CHOKE CHERRY SERIES

P. VIRGINIANA Linn., Sp. Pl. ed. 1, 1:473 (1753)
P. VIRGINIANA DEMISSA Torrey, Bot. Wilkes' Exped. 284 (1854)
P. demissa Walp., Rep. Bot. Syst. 2:10 (1843)

THE BLACK CHERRY SERIES

P. SEROTINA Ehrh., Beitr., 3:20 (1788)
P. SEROTINA SALICIFOLIA (H. B. K.) comb. nov.
P. salicifolia H. B. K., Nov. Gen. Sp. 6:241, t. 563 (1823)
P. capuli Cav., in Sprengl. Syst. Veg. 2:477 (1825)
Cerasus capollin DC. Prodr. 2:539 (1825)

FIELD NOTES ON CHERRIES

I. AS TO VARIETIES

1. EXPLANATORY STATEMENTS

Several years ago the Vermont experiment station had a small orchard and nursery containing a considerable collection of hardy varieties of fruits including a select number of the most promising russian importations. The station work was moved, however, in 1891, and the tree plantings had to be moved also. Partly because no suitable place was ready on the new grounds, and partly for other reasons, it was thought best to distribute most of the young trees to farmers and orchardists in different parts of the state. A record was kept of each tree, and from time to time reports have been secured on a part of the stock. A certain number of those to whom trees were sent have failed entirely to report or to answer inquiries. A considerable number of the trees did not flourish in their new quarters, a result which was foreseen at the time of their expedition. The notes secured from such trees as have thrived and fruited have been, however, preserved and collated, and seem to furnish some information worthy of circulation in this state.

For two or three different reasons the cherries which were sent out have done much better than the apples, pears or plums. One of these reasons which is of considerable general interest lies in the fact that the several varieties of cherries imported from Russia seem to be, as a whole, much better adapted to our conditions than are the russian apples, pears and plums, and the fruit also seems to be more satisfactory to our taste. In other words, a much larger proportion of good varieties are to be counted in the list of russian cherries than among other russian fruits.

The list of cherries (not all russian) sent out at the time referred to is given below. The asterisk (*) marks those which are reported alive with notes more or less meager. The dagger (†) indicates varieties reported dead. Varieties unmarked have not been reported.

DISTRIBUTION LIST OF CHERRIES

†Abbesse
*Belle de Choisy
Bessarabian
Cerise d'Ostheim
Double Natte
†Galopin
*Griotte du Nord
*June Amarelle
*King Amarelle
*Lithauer Weichsel
*Montmorency extraordinaire
*Morello hâtive
*Orel Sweet
*Riga 108
†Shubianca
*Spaete Amarelle
*Strauss Weichsel
*Vladimir
*Wier 44
†63 M
*Amarelle Boquet
*Bender
*Brusseler Braun
*Early Morello
Formige Weichsel
*George Glass
*Gros Gobet
Kazan Seedling
*Koeper
*Montmorency ordinaire
*Morello fruhe
Orangen Kirsch
Red Muscateller
*Schatten Amarelle
Sklanka
Susse fruhe Weichsel
*Vilne Sweet
Wier 2
*Wragg
*347

Several of the varieties marked in the foregoing list by the asterisk bore fruit in 1898. Some had fruited before. A number of the present cultivators of these bearing trees were kind enough to send us samples of the fruit during the summers of 1898 and 1899 in addition to their written reports. The variety names were verified as far as possible in such cases and descriptions of the fruit entered in the station records. Several varieties are also fruiting in the experimental grounds at Burlington, and it has been possible to make some notes in other orchards. Several cherry growers have been consulted and have given valuable aid. From all these sources the notes have been collected and condensed into the descriptive and historical paragraphs below.

Before going on to the discussion of particular varities it may be said in general that only the sour cherries succeed here, and more especially only those of the Morello class. The sweet cherries belong properly in the peach belt. Sweet cherries are occasionally grown by enthusiasts, but so are peaches sometimes grown in Vermont.

The sour cherries are usually divided into two classes, but unfortunately, leading authors do not agree as to how these classes should be constituted nor as to what varieties should go into them. The sour cherries are therefore discussed without further classification in the following notes.

Two terms, however, which recur rather frequently in the nomenclature of cherries should be specially noticed. These are *Amarelle* and *Griotte*. The term *Amarelle* apparently comes from northern Germany and is said to signify bitter. Leroy says:[1] "The Germans have given the name of *Amarelles* to their bright red-skinned Griottes, several of which are cultived in France. . . . . In Languedoc and Provence this same term was formerly applied to a species of wild cherry, called botanically *Cerasus silvestris amara*. They called the tree *Amarel* and the fruit *Amarelos*, these names being taken from the Latin *amara*, bitter, a distinguishing character of these cherries of the woods."

Thomas[2] divides cherries into six pomological classes, of which two are *Amarelles* and *Griottes* respectively. The former he characterizes as "sour cherries, known throughout the world by their watery flesh, their refreshing acid flavor, and by the dwarfish, small-foliaged trees." Bailey[3] has applied the name *Amarelle* to a subdivision of the sour cherries which he describes as having pale red fruits and uncolored juice. The term has certainly not been applied in this sense to the varieties imported from Russia, such as Schatten Amarelle, Spaete Amarelle, etc., neither do all the russian Amarelles belong to the Morello class as distinguished by Bailey (*loc. cit.*)

1 Dictionnaire de Pomologie 5, p. 163, (1877).

2 O. Thomas, Guide Practique de l'Amateur des Fruits, p. 14 (1876), (Frères Simon-Louis, Plantieres-les-Metz, Germany.)

3 Cornell Sta, Bul. 98 p. 471, (1895).

The word *Amarelle* has been carelessly translated Morello by some horticulturists, but this is incorrect, from the standpoint both of lexicography and of horticulture. The word is evidently in popular use in its native country, and like all terms in vulgar usage, it has been loosely and indiscriminately applied. At present there is no english equivalent for the term, and it has no definite pomological meaning.

The word *Griotte* seems to be of french origin, and also current with the unliterary class. Various derivations have been suggested, but no one has been verified, and none throws a flood of light on the application of the word. Decandolle[1] makes a botanical variety of the Griottes, which he calls *Cerasus caproniana griotta*, and describes with the phrase "fruit depressed globose, dark purple, flesh red." Thomas (*loc. cit.*) characterizes his group of Griottes as "very sour cherries, generally but little esteemed as table fruits, but turned more generally to culinary uses; the trees resemble those of the preceding race (the Amarelles)." In general, however, the term seems to signify any wild seedling cherry, just as we designate our roadside apples as "seedlings" or "natural fruit." Indeed I have found the word Griotte defined in a leading french dictionary as *sauvageun*, the same term as applied by the french people of this county to the wild apples.

The term *Weichsel* is simply another german dialect word used to designate a wild sour cherry. Various authors have used it with various definitions, but as generally applied it means nothing more than here indicated.

2. DESCRIPTIVE, HISTORICAL AND NOMENCLATURAL NOTES

BENDER

Fruit round, medium to large, dark red, with red flesh, very long stem, large stone, quality good. Notes from specimens furnished by William T. Dewey, Montpelier, trees from experiment station. An American variety not very well known.

BESSARABIAN

Tree rather strong growing, shapely, strong and hardy; fruit large, round or slightly oblate, dark red, short strong stem, pit medium size, quality excellent. Ripens here July 10–25. One of the best russian varieties. See figure 1.

BRUSSELER BRAUN

(Passing under the name of Lutovka in some collections). The true Brusseler Braun as grown by L. M. Macomber, North Ferrisburgh, is a fine round, large, deep dark red cherry with light red meaty fruit, a long strong stem, and a rather large oblong stone; flavor sprightly acid, quality good.

1 Prodromus vol. 2, p. 537. (1825)

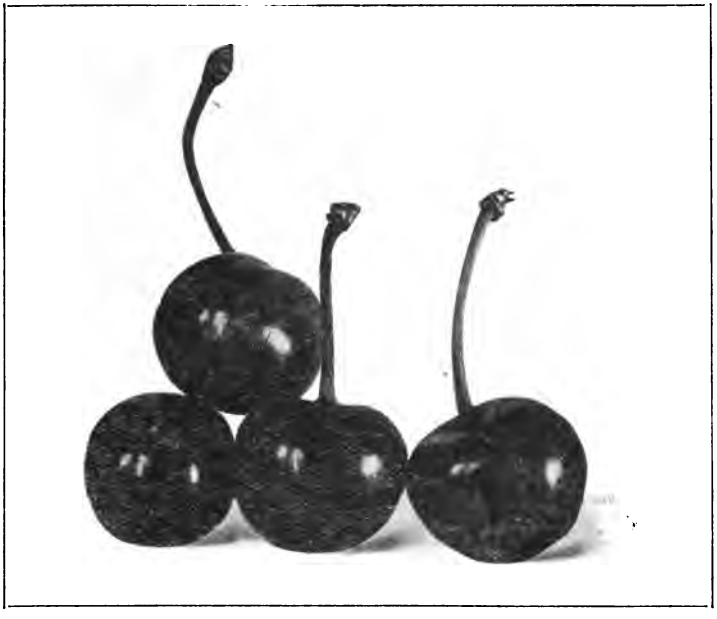

Fig. 1. BESSARABIAN

Characterized by its comparatively short stem

This is one of the finest sour cherries extant for most localities in this latitude. See figure 2.

We have had specimens of what is probably the same variety from R. S. Hall, Ascutneyville, grown on trees of the station distribution.

GRIOTTE DU NORD

Tree rather small and compact; fruit medium to large, spherical, dark red with red flesh, stalk long; quality good. This has fruited only once with us, but seems to have some considerable value. Downing makes Griotte Ordinaire du Nord a synonym of Morello, but as we have grown Griotte du Nord (brought by Budd from Silesia) it is quite distinct.

JUNEAT AMARELLE

Fruit somewhat oblate, large, bright light red, yellow flesh, long stem, small round stone, quality first class. Grown by M. H. Miller, Pomfret, as sent out by this station. Also fruited here. See figure 3.

KING AMARELLE

Fruit round, small, light red, flesh white and soft, stem long, stone small, flavor sour, quality only fair. Grown at the station; also by W. H. Ricker, Ryegate, from station stock. See figure 4.

LITHAUER WEICHSEL

Fruit somewhat oblate, quite small, very dark red, flesh red, stem long and slender, stone large, quality good, though the small size of the fruit is against it. Our notes are taken from specimens grown by J. E. Lord, Pompanoosuc, on trees sent out by the station. Medium late. This variety is of the Vladimir type, and probably no better than that variety.

MONTMORENCY

Tree an upright strong grower; fruit large, very light red, broad and somewhat flattened, flesh nearly colorless. The Montmorency is an old french variety, or, rather, a group of varieties, there being several Montmorencies in cultivation, even in this country. Among cherry growers and nurserymen, at least in the eastern states, the name seems now to be fairly well understood, however, and to be applied to the large and excellent cherry described above. Bailey has concluded that this is not the Montmorencie ordinaire of french literature, but more probably the one designated by the simple name Montmorency. There are one or two other Montmorencies in cultivation in Quebec. See figure 5.

MONTMORENCIE EXTRAORDINARIE

Fruit round, medium to large, very dark red, flesh deep red, meaty, juice red, quality fair. Late, about July 25 to August 1. Grown by G. W. Seward, Mendon, and by D. W. Stevens, Greensboro Bend. Trees sent out by this station. This is one of the Budd importations. It is similar to Montmorency, but its exact position with regard that variety or with regard to the Montmorencie extraordinaire of french pomological works can not be made out at this time.

MORELLO (English Morello)

A strong, vigorous-growing, rather spreading tree, but not of large size, fruit round or slightly elongated, medium to large size, dark red with red flesh, strong, long stem and large stone, quality good. Ripe from the middle of July onward. One the best cherries known for general culture. Downing wrote in 1850: "The true Morello is yet very scarce in this country." He then proceeded to describe the "Common Morello, largely cultivated in some districts" as a smaller type of the foregoing; but from his figures and description it seems probable that the form now in common cultivation is the one which Downing meant to characterize as the true Morello.

An Early Morello is cultivated in some localities and sold by some nurserymen. It is small in size, inferior in quality and not to be recommended.

OREL

In Budd's importation there were several varieties brought from Orel, Russia, under various numbers. In the various distributions of these

several sorts about the country the numbers have not always been carefully regarded, so that we are unable, without further time and study, to discriminate among them. It is therefore impossible to make any report here upon varieties under this name. Orel 23 and Orel 25 are favorably reported from Canada. Orel 23 is highly spoken of in Iowa.

Orel 25, the one most generally distributed in this section, is described as follows: Fruit borne singly or in clusters, large, heart-shaped, skin light red, juice uncolored, flesh tender, very juicy, sub-acid, pit medium to small. Season August 1–15.

Fig. 2. BRUSSELER BRAUN
Characterized by its comparatively long stem

OSTHEIM

Under the names of Ostheim, Ostheimer, Cerise d'Ostheim, and Griotte d'Ostheim, there are several similar varieties in circulation. We have one or two of them, and have seen specimens of others, some of them valuable, but until the nomenclature of this group can be cleared up nothing further can be said.

The description of the true Ostheim runs as follows: Fruit large, somewhat heart-shaped, dark red or brownish black when fully ripe, stem long, flesh tender, deeply colored, quality good. Season July 15–25.

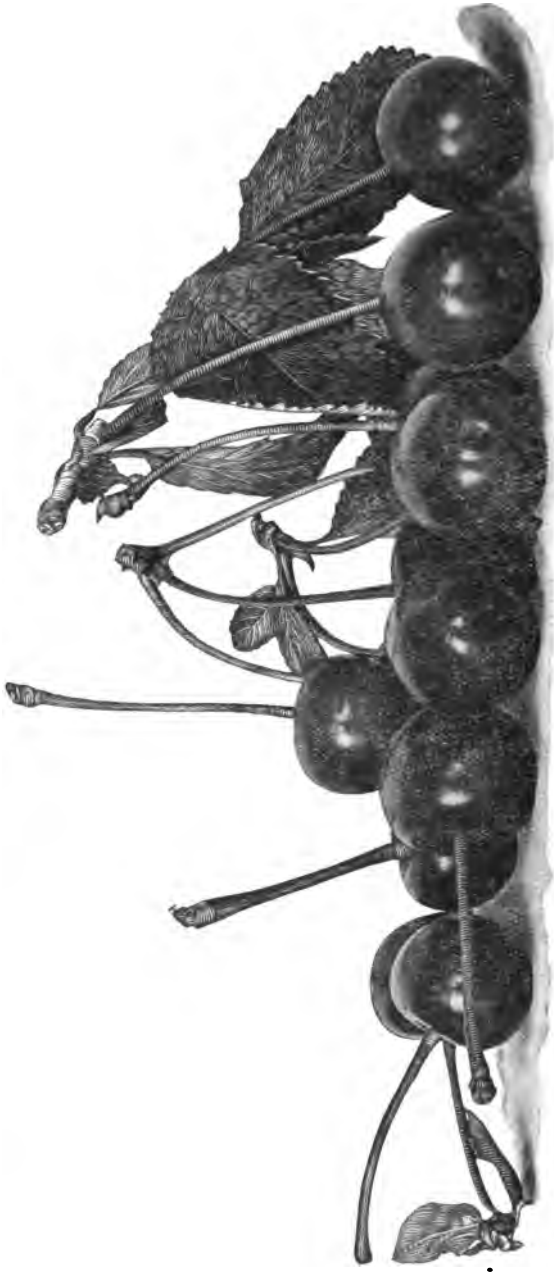

Fig. 3. JUNEAT AMARELLE
A good example of the Morello class, and a promising variety

SCHATTEN AMARELLE (Shadow Amarelle)

Fruit round, large, long stemmed, deep dark red, flesh red and solid, pit medium size and inclined to be free, quality fine. Grown by A. E. Manum of Bristol as sent out by this station and also fruiting here.

SPATE AMARELLE (Late Amarelle)

We have had this variety growing in our experimental grounds but it has not yet borne enough to justify a report.

VLADIMIR

Though this variety is often mentioned we have not yet seen specimens. It is described as being a very hardy variety of some general value. It was thought by the late Charles Gibb to be of the first importance.

WRAGG

A dwarfish spreading, strong, hardy tree; fruit round, medium to large in size, bright dark red, flesh yellow, juice light colored, stem strong, medium long, stone large, quality good. As grown at the station this variety is extremely productive and quite desirable. Ripens late, July 20 to 25.

3. MEMORANDUM OF DESIRABLE VARIETIES

The commonest and hardest question propounded to the station man is, what are the best varieties? Usually it is impossible to give a direct answer. The best variety is the one with which the grower succeeds best, and that is usually the one he likes best. Were a man to ask me which woman would be best for him for a wife I would hesitate to point out any one. It would depend largely on his own personal preference,—and here. The selection of horticultural varieties for another man has the same limitations.

Nevertheless one may safely give his experience and his own personal opinion to a man who has no knowledge of varieties, and so we yield to the constant importunities of our correspondents and give herewith a memorandum of personal opinion as to the best varieties for the beginner. The experienced cherry grower is likely to have an opinion of his own which is of more value to him than that expressed here.

Perhaps two varieties of sour cherries are enough for the ordinary farm. If they are, Morello and Montmorency may be recommended first. If a third variety were to be grown Brusseler Braun is the best of those which we have seen. Next we would choose Wragg, and next Bessarabian. Then follow Schatten Amarelle, Griotte du Nord, and Juneat Amarelle.

II. AS TO CULTURE

Soil.—The cherry tree requires a dry soil. It will grow on poor, rocky or thin soils, and without much plant food, but it will not thrive on wet land. Of course it is not at its best on poor soils, and, like other plants, will repay better treatment, but it should never be heavily fed.

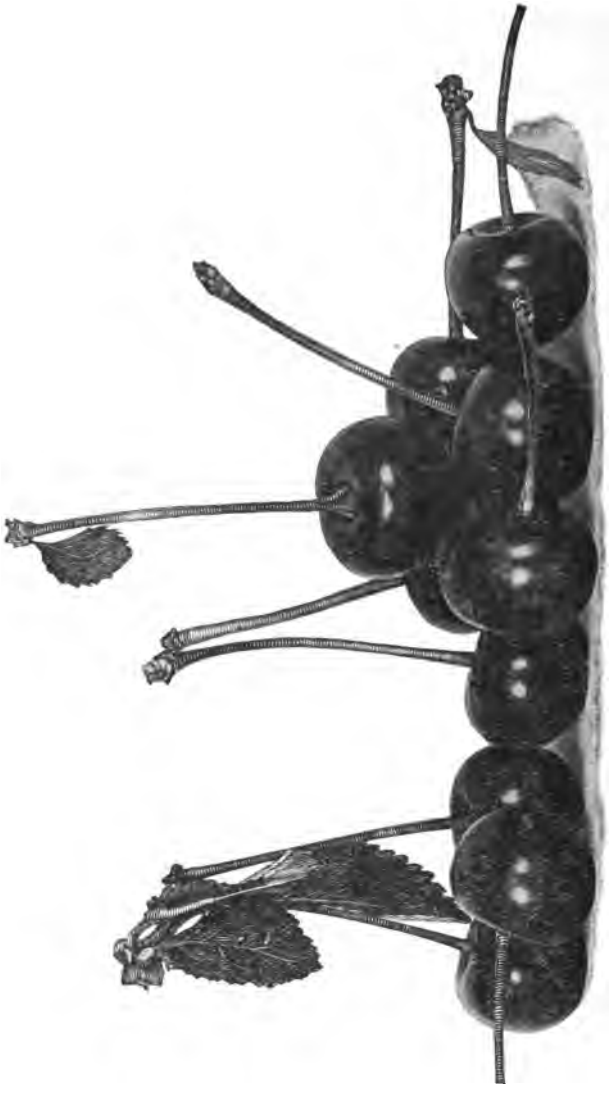

Fig. 4. KING AMARELLE
Another promising variety of the Morello class

Cultivation.—Standard cherry trees should be set 12–20 feet apart, depending on the varieties. Fifteen feet is a safe distance for common varieties on ordinary soils. Morellos on strong soils should have 20 feet. Cherries may be grown in sod, and will do comparatively better in such circumstances than apples. Still if one is really in earnest is his growing it will pay to cultivate cherries much as the best fruit growers manage apple orchards.[1] In brief this consists in a shallow plowing in spring followed by occasional surface cultivations till mid-summer, when some cover crop is sown.

Pruning.—Cherries need very little pruning. Some small effort is required during the first few years to secure trees of the best form, but such cutting as is not required in shaping the heads may usually be dispensed with. Certain varieties, especially some the Russians, are inclined to a dwarf habit, and this may be sometimes conveniently encouraged by a moderate heading in.

Stocks.—Most farmers buy their cherry trees of the nurserymen and seldom inquire what stocks they are propagated upon. There is, however, some difference to the fruit grower and a great deal to the nurseryman in the different stocks used. Mazzard and Mahaleb are the common stocks, though Morello seedlings are sometimes grown in this country for this purpose. Of these the Morello and the Mazzard are probably best for the fruit grower, in the order named, though there is an important difference of opinion among horticulturists on this point. Craig has reported[2] considerable success in budding on the common wild bird or pin cherry (*Prunus pennsylvanica*). This stock is not likely to be valuable in nursery practice, but might be worth trying by the farmer and amateur fruit grower.

Hardiness.—Practically all the sour cherries are hardy enough for any situation in Vermont. Dr. T. H. Hoskins, of Newport, whose orchard is a famous testing ground for hardy fruits, grows several varieties with success. In fact he grows them with mentionable financial profit. Certain of the russian varieties, however, mentioned in the foregoing pages are thought to be unusually hardy. Vladimir and Schatten Amarelle are recommended to very timid planters.

Diseases and insects.—The enemies with which the cherry grower has to contend in this country are (*a*) black knot, (*b*) brown rot of the fruit, (*c*) curculio, (*d*) birds. The one safe and practicable protection against curculio and birds is to grow cherries enough for them and for the family or market besides. Black knot is seldom troublesome, but has been very serious

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1 For a discussion of the cultivation of apple orchards see Vt. Sta. Bul. 55.

2 Cent. Exp. Farm (Ont.) Bul. 17, p. 19, (1892).

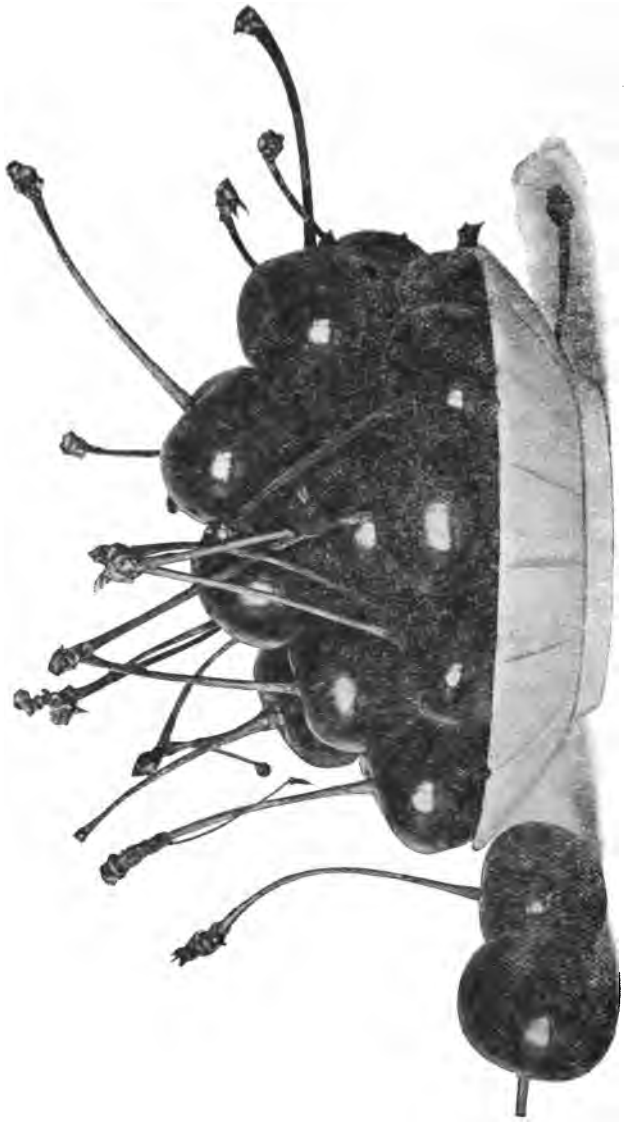

Fig. 5. MONTMORENCY
One of the old, reliable, and well known varieties

the past year or two. The fruit rot is not likely to do great damage in this state.

Picking, marketing, etc.—Cherries should be picked with the stems on. If they are for market this is imperative. When the fruit rot is bad it is necessary to attend very closely to the picking for the cherries rot with astonishing rapidity when they are once ripe. They should be picked as soon as is consistent with good quality, and the picking should be done when the sun shines and the fruit is dry.

In sending cherries to market, under present conditions in Vermont, the common quart boxes used for strawberries are best. Cherries ought to be plenty enough so that they could be sold by the peck. Think of selling potatoes or apples by the quart! The fact is there are not one-tenth as many cherries grown in Vermont as the market demands. How many could be used if they could be had in quantity at reasonable prices nobody knows.

It is a very regretable state of affairs, to say the least, when it is practically impossible to buy enough cherries for a pie in any of our Vermont village markets, and when not one farm in twenty-five grows cherries enough for home use. The cherry is a most healthful and refreshing fruit and should be used in abundance. It is one of the finest fruits for canning, but it must be grown in greater quantity than at present before common folks can afford to put it up for winter use. *It is perfectly safe to say that there is a ready and profitable home market in Vermont for twenty-five times the quantity of cherries now grown,—and cherries are easier to grow than potatoes.*

DAIRYING

By J. L. Hills

Dairy husbandry and more particularly experiments touching the methods of conducting feeding trials with cows as well as the relative worth of sundry rations have continued to engross the larger part of the time of the agricultural and chemical departments. It is hoped that in time investigations may be undertaken of problems more directly relating to butter and cheese making.

The experiments completed and written up since the eleventh report was issued are grouped under the following headings:

Feeding tests and their methods

- I. Introduction
- II. Statement of methods and details of conduct of tests
- III. The relative feeding values of rations of equal balance
  - (1) Test with medium nutritive ratios
  - (2) Test with wide nutritive ratios
- IV. The effect upon production of the addition to the ration of emulsified or unemulsified fat
- V. The relative feeding values of medium and of wide rations
  - (1) Grain rations equal in amount
  - (2) Grain rations unequal in amount
- VI. The feeding value of buckwheat middlings
- VII. The feeding value of artichokes
- VIII. Watering at will and at stated intervals
- IX. The grooming of cows
- X. Experimental error in feeding tests
- XI. Relative values of various grain rations
- XII. Summary

The effect of food upon the quality of butter

Record of the station herd for 1897–98

Sundry forage crops

The effect of fatigue upon the quantity and quality of milk

Appendix containing condensed data pertaining to article on "Feeding tests and their methods."

FEEDING TESTS AND THEIR METHODS

This article is summarized at its close some forty pages further on in this volume. The results are concisely stated therein and cross references given.

I. INTRODUCTION

The general line of feeding tests with cows begun in the winter of 1896–97 has been followed in the work of the past season. Somewhat more stress than heretofore, however, has been laid upon the comparison of the relative food values of different rations. The equipment of the station is in many ways well adapted to experimentation in this line. The large size of its herd in particular permits wide range in choice of animals, much repetition of experiments and the conduct of a relatively large number of trials.

The feeding experiments of the past winter were designed to increase our information upon several points. Some of the tests were in continuation of similar trials in previous years (*a*, *b*, *c*, *d*, *e*) while the others pertained to matters not hitherto considered at this station. The questions which the trials were designed to aid in answering were as follows:

(*a*) What variations in production are to be expected from different rations—i. e., those made up to some extent of different materials—each containing essentially the same amounts of the various nutrients?

(*b*) What effect upon production has the addition to the ration of liquid fat, emulsified or unemulsified?

(*c*) What variations in production are to be expected from different rations, each containing essentially the same amounts of digestible dry matter, but different amounts of various nutrients, or, in other words, "medium" and "wide" rations?

(*d*) What variations in production are to be expected from different rations, each containing different amounts of digestible dry matter and of all digestible nutrients, or, in other words, "medium" rations fed in medium quantity and "wide" rations fed in relatively scant quantity?

(*e*) What is the feeding value of buckwheat middlings compared with half and half cottonseed and linseed meals? also compared with corn and bran?

(*f*) What are the comparative feeding values of corn silage and "Improved french white artichokes?"

(*g*) What is the effect upon production if cows may drink water as they will instead of but twice daily?

(*h*) What effect has grooming cows upon production?

(*i*) What is the extent of the probable error inherent in feeding experiments due to the individuality of the animals used or to other causes?

The feeding trials were known respectively as tests of (*a*) "equal balance," (*b*) oil feeding, (*c*) medium and wide rations, (*d*) medium and wide-

scant rations, (*e*) buckwheat middlings, (*f*) artichokes, (*g*) watering, (*h*) grooming and (*i*) experimental error; and are so referred to throughout this article and in the appendix of tables.

II. STATEMENT OF METHODS AND DETAILS OF CONDUCT OF TESTS

The records of 60 cows were kept in the seven and one-half months during which the feeding trials lasted. Those of 4 cows fed for seventeen weeks during the winter and spring of 1897–98, and not hitherto reported are likewise available. The records of 8 of the original 60 cows for one reason and another are unsafe to use. Errors in feeding and shortage of supply owing to incorrect estimates seriously curtailed the data concerning the feeding value of artichoke tubers. A few cows scheduled and used in sundry experiments either began to dry off early or became ill or went off feed during the winter. It is to be expected that some troubles of this kind would follow the use of so large a number of animals fed under conditions necessitating frequent and radical changes in rations.

The 56 cows whose records are available were distributed among the tests as follows: (*a*) equal balance, 12 cows used in two series of trials with different rations; (*b*) oil feeding, 14 cows used in four series of trials, two in 1898 with 4 cows, three in 1899 with 10 cows; (*c*) medium and wide rations, 5 cows; (*d*) medium and wide scant rations, 5 cows: (*e*) buckwheat middlings. 6 cows; (*f*) artichokes, 1 cow; (*g*) watering, 4 cows; (*h*) grooming, 5 cows; (*i*) experimental error, 4 cows.

All the cows used were not equally well suited to our purposes as regards time of lactation. A long and careful study of previous records—extending over nearly five years with some animals—of ages, time of calving, flow and quality of milk, time of service, etc., prefaced choice for the various experiments. The equal balance and oil feeding tests on the whole had preference in selection.

DETAILS OF FEEDING

The feeding periods were either 4 or 5 weeks long.[1] Regardless of the length of period the first third of the time was always considered preliminary and non-experimental. Hence the periods divide into preliminary and experimental portions as follows: 4 weeks into 10 and 18 days, 5 weeks into 12 and 23 days. The experimental portions only of the periods are considered in the discussion, and are hereinafter referred to as "the period." Results obtained and conclusions drawn are based upon them alone. The preliminary portions were considered as preparatory only, being necessary to get the animal fairly upon and accustomed to its new

1 The first oil feeding period was four weeks and the second non-oil feeding period six weeks long.

diet. Notwithstanding this fact, full feeding and milk records were kept, samples of fodders and feeds taken, and analyses made in the same manner and with the same care during the preliminary as during the experimental portions. In some cases the milk was sampled in the preliminary as well as in the experimental portions of the periods.

The cows were fed twice daily, watered twice, and turned out into the yard twice. The yard exercise varied in duration from 20 to 45 minutes according to weather. Hay and grain were first fed morning and night, and after these were eaten as much silage was given as the cow would consume. The amount of hay offered each cow was uniform throughout the tests, but varied between cows according to their digestive capabilities. All fodders and feeds were weighed as fed, the orts were weighed back daily and their nature noted.

The following statement shows the general feeding plan :

The formulas, analyses, digestible constituents, etc., of the mixed feeds numbered 1 to 5, the grains from which they were formed, as well as of the roughages used which are referred to in the statement, are shown on page 260. It may be said in brief that Nos. 1 and 2 contained bran, cornmeal, cottonseed and linseed meals, No. 3 consisted of bran, cornmeal and buckwheat middlings, while Nos. 4 and 5 contained corn and bran. Mixed feed No. 1 did not differ materially in composition from No. 2.

FEEDING PLAN OF ALL TESTS

All the cows received hay in amount ranging from 12 to 24 pounds daily, about two-thirds of them ate from 12 to 30 pounds of silage daily, and a few ate 10 pounds of sugar beets each day. Artichokes were fed to several cows.

The grain feeds used in alternating periods were as follows :

Equal balance : (*a.*) 7 pounds No. 2, 8 pounds Buffalo gluten feed ; (*b.*) 8 pounds each Quaker oat feed and equal parts corn and bran.

Oil feeding, 1898 : Emulsified cottonseed oil mixed with 8 pounds of bran, and 8 pounds bran alone ; emulsified cottonseed oil mixed with 8 pounds bran and 8 pounds bran alone.

Oil feeding, 1899, (*a.*) Emulsified cottonseed oil mixed with 8 pounds equal parts of corn and bran, and 8 pounds equal parts corn and bran (No. 4) ; (*b.*) emulsified corn oil mixed with 8 pounds equal parts of corn and bran and 8 pounds equal parts corn and bran ; emulsified linseed oil mixed with 8 pounds equal parts of corn and bran and 8 pounds equal parts of corn and bran.

Medium and wide.—8 pounds each No. 1, and Quaker oat feed.

Medium and wide-scant.—8 pounds Buffalo gluten feed and 3 pounds corn and bran (No. 5).

Buckwheat middlings.—8 pounds each of mixed feeds 1 and 3; 8 pounds each of mixed feeds 3 and 4; 8 pounds each clear buckwheat middlings and 4.

Artichokes.—Mixed feed No. 1 throughout; silage and artichokes, alternating.

Watering.—Mixed feed No. 4, thoughout; methods of watering alternating.

Grooming.—Mixed feed No. 1, throughout; grooming and non-grooming alternating.

Experimental error.—Mixed feeds Nos. 4, or 2 or Buffalo gluten feed throughout; no alternation.

Comparisons of the amounts of nutrients eaten by the various cows with the Wolff and the Wolff-Lehmann standards show that while there were wide variations in eating as between the different cows and rations there was generally eaten enough and to spare of each of the ingredients except protein. In several, but not in all cases, too little protein was eaten. In most cases, however, the amount of this latter nutrient eaten approximated that called for by the Wolff standard except when oat feed or corn and bran was eaten, either in equal parts or as mixed feed No. 5. More specific statements touching the comparison with standards are made in the discussion of each test.

WEIGHTS OF COWS

All the cows under test were weighed during the first three days of the opening period, and on the last three days of all periods. Average weights are shown in table I of the appendix. About half the number gained quite decidedly in weight, about one-third did not vary materially in this respect and five cows (Acme, Inez, Flora, Jeannie and Clover) lost in weight. While variations in live weight are too uncertain things to lay much stress upon, yet a study of the table appears to show certain general trends in a few cases. On the whole no clear advantage of one ration over another in increasing live weight can be seen, except as noted, when either of the following were fed: Buffalo gluten feed, either cottonseed-linseed mixture, either corn and bran mixture, Quaker oat feed. The corn and bran ration had always a tendency to increase live weight in the oil feeding experiments. This may have been due in part to the considerable wasteage of the grain when mixed with oil. Whenever buckwheat middlings were fed live weight shrunk. The cows when drinking water at will weighed more as a rule than when drinking at intervals, probably because they had more water in their digestive systems at the time of weighing. There was a tendency towards greater weight when the cows were groomed than when not thus handled.

BARN TEMPERATURES

The cows were stabled in two portions of the barn structure, the main floor and the east wing, which leads from the main portion. The temperatures of the two stables were taken daily at 5 A. M., 12 M., and 6 P. M. The exposed location of the station barn causes decided fluctuations in the temperature of the cow stables during the winter, notwithstanding the comparatively large number of animals housed therein.

The average barn temperatures, morning, noon and night, during each period, the ranges of variation and the per cent of the entire number of observations within 3° F. or the mean of each period are tabulated in the appendix. Average variations of 5° or more from means for considerable periods occurred on about 20 days. For several years a careful study has been made in connection with feeding tests of the fluctuations in yields and of qualities of the milk occurring coincident with, immediately preceding, and immediately succeeding wide thermometric changes. No definite relation has been traced between variations in barn temperatures and in the quality of the milk. Some samples have shown more or less quality fluctuations inverse to temperature changes, others in the same direction, while in many cases no change occurred. It has been held safe to assert that these few changes, mostly slight in amount, had practically no influence in modifying period averages, each of which was based on analyses of several composite samples of milk.

Careful comparisons of variations in milk yield with temperature changes were made and five cases of possible relationship were noted, as follows:

Dec. 1–5,	3½° above	mean,	1½ per cent. increase in milk flow.
Jan. 23–28,	4° "	"	3 per cent. " " " "
Feb. 6–13,	2½° below	"	3 per cent. decrease " " "
Feb. 17–23,	3° above	"	1½ per cent. increase " " "
Apr. 3–12,	3½° below	"	2½ per cent. decrease " " "

These cases, which were much the largest fluctuations occurring coincident with temperature changes extending over more than a day or two, are so small as to be quite without effect upon the average of results obtained in periods of from 18 to 23 days in length. A more uniform barn temperature would have been an advantage; but it is judged from these comparisons that temperature variations had little if any effect upon the final results. It should be noted, moreover, that since all the cows were housed together, these effects, if any, might be expected to be uniformly exerted upon all. It should be remembered also, in this connection, that all the cows were turned out daily for from twenty to forty minutes.

The following tables show the period dates and the cows in use, with the nature of the grain feed eaten during each period. The names which are italicised are those of Ayrshires registered or registerable, the black faced letters indicate Jerseys registered or registerable, while the names given in ordinary type are those of high grade Jerseys.

COWS USED AND NATURE OF GRAIN RATIONS FED DURING EACH PERIOD

Name	Approximate age Nov. 1	Calved 1898	Served 1899	Period numbers I	II	III	IV	V	VI	VII	VIII
Equal balance											
Sue	3	June 24	Jan. 27	II	B G	II	B G	II	B G	.....	.....
Haidee	3	Aug. 16	Feb. 9	B G	II	B G	II	B G	II	.....	.....
Atalanta	9	Nov. 16	Farrow	....	B G	II	B G	II	B G	.....	.....
Nancy B	11	Nov. 6	Feb. 5	....	II	B G	II	B G	II	.....	.....
Goldie	12	Aug. 10	Farrow	II	B G	II	B G	II	B G	.....	.....
Eva	..	Late sum.	Oct. 1 '98	B G	II	B G	II	B G	.....	.....	.....
Acme 5th	9	Dec. 25	Farrow	....	.....	II	B G	II	B G	.....	.....
Golden Rod	7	May 11	"	IV	O F	IV	.....	.....	.....	.....	.....
JERSEY LILY	7	May 10	Mch. 23	O F	IV	O F	.....	.....	.....	.....	.....
Viola	2	Jan. 3 '99	May 13	....	.....	IV	O F	IV	O F	.....	.....
Jeannie	9	Mch. 16	Farrow	....	.....	....	.....	.....	O F	IV	O F
Clover	11	Mch. 1 '99	April 17	....	.....	....	.....	.....	IV	O F	IV
Oil Feeding 1898											
Acme 5th	..	Jan. 18	....	Br	*Br&	Br.	.....	.....	.....	.....	.....
MINTA BELLA	..	Jan. 10	....	"	"	"	.....	.....	.....	.....	.....
Red Top	..	Feb. 7	....	"	"	"	.....	.....	.....	.....	.....
Polly	..	Feb. 5	....	"	"	"	.....	.....	.....	.....	.....
Oil Feeding 1899	..										
Eulalie	9	Nov. 12	Jan. 23	....	†IV &	IV	†IV&	IV	.....	.....	.....
Rose	3	Oct. 26	Farrow	IV	"	"	"	"	.....	.....	.....
Lala	6	Nov. 12	"	....	"	"	"	"	.....	.....	.....
Dime	2	Jan. 8 '99	April 6	....	.....	"	"	"	.....	.....	.....
Edna	..	Mid-sum.	Farrow	IV	‡IV&	"	‡IV&	"	.....	.....	.....
Annie	3	Nov. 9	Feb. 11	....	"	"	"	"	.....	.....	.....
Ceres	8	*Sept. 18	Nov. 1 '98	"	"	"	"	.....	.....	.....	.....
Rowena	7	Mch. 27	Farrow	IV	§IV&	"	§IV&	.....	.....	.....	.....
Red Top	9	Feb. 7	"	"	"	"	"	.....	.....	.....	.....
Marjory	10	Farrow	Dec. 1	....	"	....	.....	IV	.....	.....	.....
Medium and Wide											
Bettie	10	Feb. 6	April 28	I	O F	I	.....	.....	.....	.....	.....
Fairie	9	Mch. 9	Farrow	O F	I	O F	.....	.....	.....	.....	.....
MINTA BELLA	7	Nov. 6	May 5	....	.....	1 II	O F	I	O F	.....	.....
Flora	9	Feb. 7 '99	April 28	....	.....	.....	.....	I	O F	I	.....
Dandelion	9	Feb. 28 '99	Nov. 12	....	.....	....	.....	.....	I	O F	I
Medium and wide Scant											
Polela	4	Jan. 10 '99	April 15	....	.....	....	V	B G	V	.....	.....
Pauline	3	Dec. 16	Mch. 4	.....	.....	B G	V	B G	.....	.....	.....
Inez	..	Mid-sum.	Feb. 9	V	B G	V	B G	V	B G	.....	.....
Priscilla	3	Nov. 25	Feb. 12	..	V	B G	V	B G	.....	.....	.....
Sylvia	..	Aug. 15	Nov. 12'98	V	B G	V	B G	V	B G	.....	.....
Buckwheat middlings											
Adah	2	Nov. 22	Farrow	....	.....	II	III	II	III	.....	.....
Maizie	12	Nov. 23	"	....	.....	I	III	I	III	.....	.....
Salida	5	Feb. 21 '99	April 24	....	.....	....	.....	.....	I	III	I
Naomi	3	Feb. 1 '99	Mch. 17	....	.....	....	.....	I	III	I	.....
Max Ella	7	Nov. 22	April 11	....	IV	III	IV	III	IV	.....	.....
Orpha	..	Mid-sum.	Dec. 1	....	.....	....	.....	.....	IV	B M	IV
Artichokes											
LADY PERUSIA	5	*Oct. 10	May 3	Si	Art.	Si	.....	.....	.....	.....	.....
Watering											
Hazel	2	Dec. 11	Farrow	....	.....	....	.....	Will	Yd	Will	.....
Lilac	2	Jan. 24 '99	"	....	.....	....	Yd	"	"	"	.....
Clare	11	Jan. 22 99	"	....	.....	....	"	"	"	"	.....
Pussy Willow	7	Jan. 24 99	Mch. 29	....	.....	....	"	"	"	"	.....
Grooming											
Leah	2	Nov. 22	Farrow	....	.....	....	.....	N. Gr	Gr	N. Gr	.....
Polly	10	Feb. 9 99	"	....	.....	....	.....	Gr	N. Gr	Gr	.....
Pomona	7	Jan. 31 '99	Mch. 20	....	.....	....	.....	N. Gr	Gr	N. Gr	.....
LADY PERUSIA	5	*Oct. 10	May 3	....	.....	....	.....	N. Gr	Gr	N. Gr	.....
Bonny Belle	2	Dec. 6	Farrow	....	.....	....	.....	N. Gr	N. Gr	Gr	.....
Experimental errors											
Brownie	9	*Sept. 10	Farrow	....	.....	IV	IV	IV	.....	.....	.....
Rachel	7	Oct. 5	Feb. 7	....	.....	IV	IV	IV	IV	IV	.....
Star Bright	2	Dec. 14	Jan. 27	....	.....	B G	B G	B G	B G	B G	.....
MAX BELLE	6	*Aug. 7	Farrow	II	II	II	II	II	II	II	.....

*Br & cottonseed oil : †IV & cottonseed oil ; ‡IV & corn oil ; §IV & linseed oil
1 Fed through error for No. 1, which it closely resembles.

DATES OF FEEDING PERIODS

		Equal balance, medium and wide, medium and wide scant, buckwheat middlings, artichoke & experimental error	Oil feeding	Equal balance buckwheat middlings; watering and grooming
I	Preliminary	Oct. 25-Nov. 6	Oct. 25-Nov. 6	Oct. 25-Nov. 4
	Experimental	Nov. 6-29	Nov. 6-29	Nov. 4-22
II	Preliminary	Nov. 29-Dec. 11	Nov. 29-Dec. 9	Nov. 22-Dec. 2
	Experimental	Dec. 11-Jan. 3	Dec. 9-27	Dec. 2-20
III	Preliminary	Jan. 3-15	Dec. 27-Jan. 11	Dec. 20-30
	Experimental	Jan. 15-Feb. 7	Jan. 11-Feb. 7	Dec. 30-Jan. 17
IV	Preliminary	Feb. 7-19	Feb. 7-19	Jan. 17-27
	Experimental	Feb. 19-March 14	Feb. 19 March 14	Jan 27-Feb. 14
V	Preliminary	March 14-26	March 14-26	Feb. 14-24
	Experimental	March 26-April 18	March 26-April 18	Feb. 24-March 14
VI	Preliminary	April 18-30	April 18-30	March 14-24
	Experimental	April 30-May 23	April 30-May 23	March 24-April 11
VII	Preliminary			April 11-21
	Experimental			April 21-May 9
VIII	Preliminary			May 9-19
	Experimental			May 19-June 6

MILKING AND MILK SAMPLES

Every milking was weighed from the outset to the end of the feeding trials. Composite samples of six and eight milkings were taken continuously during the experimental portions of the periods, and during the preliminary portions as well in several of the tests. These were analyzed by the Babcock centrifugal method for fat, while the total solids were furnished by the Quevenne lactometer, the Hehner and Richmond formula ($T=1.2\,F+(L\div 4)+0.14$), the fat percentage, and the milk slide-rule.

FODDERS AND FEEDS

The fodders and feeds were sampled once a fortnight, 359 samples of roughages and of concentrates (grain feeds) being taken. All samples were individually analyzed for their dry matter content, and were then combined to make 64 composite samples for complete analysis.[1] A table of analyses and of digestible coefficients and nutrients, appears in the appendix; the averages of these are shown below.

AVERAGE ANALYSES OF FODDERS AND FEEDS

Fodders and feeds	Original substance		Composition of dry matter							
	Water	Dry matter	Crude ash	Crude protein	Crude fiber	Nitrogen-free extract	Ether extract	Nitrogen	Phosphoric acid	Potash
Hay	12.88	87.12	7.98	9.89	33.90	46.35	1.87	1.58	0.60	1.94
Silage	70.25	29.75	7.33	7.89	20.80	60.98	3.00	1.26	0.60	1.52
Sugar beets	77.90	22.10	17.38	5.67	6.20	70.31	0.46	0.90	0.40	1.52
Artichokes	77.50	22.50	10.14	9.97	4.00	75.35	0.54	1.60	0.63	2.24
Artichoke tops	25.75	74.25	9.47	5.66	29.56	54.07	1.24	0.91	0.39	1.41
Cottonseed meal	6.82	93.18	7.88	47.21	5.76	27.70	11.45	7.55	3.32	2.12
Linseed meal (N. P.)	8.06	91.94	6.85	39.56	9.87	41.44	2.28	6.33	1.98	1.53
Wheat bran	8.52	91.48	7.36	16.69	11.40	59.09	5.47	2.67	3.37	1.96
Corn meal	9.89	90.11	1.67	10 44	1.81	81.79	4.29	1.67	0.61	0.42
Oat feed	7.06	92.94	5.77	11.01	17.96	61.10	4.16	1 76	0 88	0.75
Buffalo gluten feed	7.82	92.18	3.97	27.35	7.11	58.50	3.07	4.38	1.20	0.61
Buckwheat middlings	9.30	90.70	4.62	22.94	4.04	62.21	6.19	3.66	1.95	0.99
2 Mixed feed No. 1	8.53	91.47	6.11	25.10	8.07	54.56	6.16	4.02	2.47	1.60
" " No. 2	8.24	91.76	6.52	27.01	8.75	51.62	6.10	4.33	2.74	1.74
" " No. 3	9.34	90.66	5.54	19.76	6.69	62.12	5.89	3.16	2.36	1.44
" " No. 4	8.95	91.05	4.54	13.62	6.54	70.04	5.26	2.18	1.95	1.22
" " No. 5	8.97	91.03	3.75	12.75	5.45	73.12	4.92	2.04	1.65	1.05

1 For more complete statement of methods of sampling and for individual analyses see table III in appendix and footnote to same.

2 The mixed feeds were made up as follows:

No. 1, cottonseed meal 3 parts, linseed meal 3 parts, corn meal 4 parts, wheat bran 6 parts.

No. 2, cottonseed meal 3½, linseed meal 3½, corn meal 3, wheat bran 6 parts.

No. 3, buckwheat middlings 4, corn meal 1, wheat bran 3 parts.

No. 4, equal parts cornmeal and wheat bran.

No. 5, cornmeal 8, wheat bran 4 parts.

AVERAGE DIGESTIBLE INGREDIENTS IN FODDER AND FEEDS

Fodder and feeds	Dry matter	Protein	Crude fiber	Nitrogen-free extract	Ether extract	Nutritive ratio
Hay	50.53	4.57	16.54	24.63	0.88	1:9.5
Silage	22.31	1.72	4.77	13.64	0.74	1:11.7
Sugar beets	20.99	1.13	1.36	15.53	0.05	1:15.0
Artichokes	21.37	2.04	0.90	16.90	0.07	1: 8.8
Artichoke tops	52.72	2.73	16.68	29.31	0.64	1:17.5
Cottonseed meal	70.81	38.71		16.59	10.07	1: 1.1
Linseed meal (N. P.)	72.62	32.38	5.17	29.72	1.87	1: 1.2
Wheat bran	55.80	12.05	2.29	37.30	3.40	1: 4.0
Corn meal	79.30	5.65		68.54	3.56	1:13.6
Oat feed	65.07	7.98	3.34	43.29	3.16	1: 6.8
Buffalo gluten feed	77.39	21.42	4.72	46.91	2.34	1: 2.7
Buckwheat middlings						
Mixed feed No. 1	67.69	19.04	1.92	39.63	4.74	1: 2.8
" " " 2	66.07	20.82	2.17	35.52	4.65	1: 2.3
" " " 3						
" " " 4	67.38	8.93	1.13	52.93	3.74	1: 7.1
" " " 5	71.91	8.01	0.84	57.90	3.71	1: 8.4

RECORDS OF THE FEEDING TESTS

Never before have so many cows been included in feeding experiments at this station as during the past winter. The experimental feeding and care of 60 cows for from three to seven and a half months involved a vast amount of labor. It necessitated nearly 70,000 barn weights and records, the analysis of 359 samples of fodders and feeds for dry matter, of 64 similar materials for the various crude nutrients (complete analysis) and of over 1500 composite samples of milk for fat and specific gravity. And, finally, many hundreds of hours of work were spent in the collation and calculation of the multitudinous records of the tests in preparation for publication. All the mathematical work in connection with this, as with all similar station work, was done in duplicate, usually by different persons, and was accomplished so far as possible with the aid of calculating instruments. It is thought to be absolutely accurate. The detailed data if printed would add more than 200 pages to this report. Even when condensed into the briefest possible compass it occupies much space. Our usual custom of placing in an appendix the condensed data which forms the basis for our conclusions has been followed in the present case. It is there of ready reference to those interested, but does not stand in the way of that larger class of readers who care only for the text and for the smaller tables showing final results. Only those tables absolutely necessary to the explanation of the text are included in the body of the articles. The main tables appear in the appendix to this volume under the following headings:

APPENDIX CONTAINING CONDENSED DATA PERTAINING TO ARTICLE ON FEEDING TESTS AND THEIR METHODS

I. Weights of cows.

II. Average barn temperatures, with ranges and percentages of uniformity.

III. Analyses and digestible ingredients in fodders and feeds; (*a*) analyses on dry basis, and pounds of digestible nutrients in 100 pounds of original substance; (*b*) digestion co-efficients.

IV. Feeding records of the individual cows in feeding tests.

V. Production records; showing production and same per unit for each individual cow in feeding tests.

VI. Difference tables. (*a*) Total of differences; (*b*) Percentage differences.

VII. Results of experimental feeding on different rations.

III. THE RELATIVE FEEDING VALUES OF RATIONS OF EQUAL BALANCE

Is it to be expected that uniform production will follow the use of equal amounts of digestible nutrients given in rations containing different fodders or feeds? Or, stating the matter in a somewhat mathematical form, if *a* pounds of digestible protein and *b* pounds of digestible carbohydrates be fed in ration I, and if, under similar circumstances, *a* and *b* pounds of these digestible nutrients be fed in ration II, will the cow's production equal *m* in each case?

The value of chemical analysis and of digestion experimentation is involved to some degree in this question. If it may be answered affirmatively the usefulness of feeding trials of the ordinary type is curtailed and queries may be propounded to the chemist and the feeding expert rather than to the cow. If answered negatively, however, she becomes of necessity their co-laborer. It has been amply proven that milk and butter yields fluctuate when varying amounts of nutrients are fed, either from the same or from different sources. It is not as clear how constant these yields may be when equal amounts are eaten derived from divers sources.

The last two reports of this station contain data bearing on the effects upon milk production of two rations differing somewhat in their ingredients but containing essentially like amounts of the various digestible nutrients. Atlas gluten meal—a distillery by-product—and half-and-half cottonseed and linseed meals were the variable portions of the rations each year, and in a secondary test made last year corn silage and corn and sunflower head silage were compared. The maintenance of an equal balance was found to be difficult because of the character of the feeds chosen and the somewhat uneven bovine appetite. In the earlier test nutritive ratios averaged 1 : 6.3 —cottonseed-linseed—, and 1 : 7.3—Atlas. The rations contained essentially equal amounts of digestible protein but diverse weights of digestible carbohydrates. In the latter trials the content of digestible carbohydrates was kept fairly constant, while that of protein varied. The same rations were used each year in the main trials, yet in the earlier ones larger production followed the use of the somewhat narrower ration, while in the latter tests of concentrates the slightly wider ration led. The differences in neither case were wide enough to lay stress upon; yet the trend of individual results was all one way one year and all the other way the next year. This would seem to indicate actual differences in feeding value, rather than accidental variations due to experimental error. In the secondary test, however, pronounced variation in production followed the use of two different rations, notwithstanding the fact that nearly even amounts of digestible nutrients were eaten and that the nutritive ratios were almost identical. The more palatable ration made the better returns.

[1] Vt. Sta. Rpts. 10, pp. 162-164 (1897), 11, pp. 330-336 (1898).

This outcome seemed so unsatisfactory and the matter so unsettled that further trials with other concentrates were undertaken. Two sets of results are at hand for the further study of this question. One was obtained with 7 cows fed for from 3 to 6 periods of 5 weeks each on hay, silage and, in alternating periods, Buffalo gluten feed and mixed feed No. 2. The other was derived from 5 cows fed for from 3 to 4 periods of 4 or 5 weeks each on hay, silage and, in alternating periods, equal parts of corn and bran and Quaker oat feed. The nutritive ratios in each test remained quite the same, averaging for the two rations in one test 1:5.6 and 1:5.7 and in the other 1:8.9 and 1:8.9. The average variation in nutritive ratios to the cow was 0.3 points in the first and 0.6 points in the second test.[1]

1. TEST WITH MEDIUM NUTRITIVE RATIOS

Feeding.—Buffalo gluten feed and a combination of cottonseed, linseed and corn meals with bran were the variables in this trial. Both rations were readily eaten. The mixed feed was formulated from analyses and calculations of digestible ingredients to match the analytical results obtained on a sample of Buffalo gluten feed said to be from the same lot afterwards sold the station. The material as fed, however, was better than the sample. The analyses of the fodder and feeds used in the trials were not made until late in the spring of 1899, owing to pressure of other work. Basing our practice on this single analysis, 7 pounds of mixed feed No. 2 were fed daily against 8 pounds of the gluten feed. Because of this variation the latter ration contained 5 per cent more total dry matter, nearly 8 per cent more digestible protein and 6 per cent more digestible carbohydrates than did the former ration. Yet had 8 pounds of mixed feed No. 2 been fed the nutritive ratios would have been unlike. Had 7.5 pounds been used the ideal would have been more nearly met. This experience gives further evidence of the difficulty of formulating two different rations of exactly equal balance containing also even amounts of nutrients. In this case the test is one of equal balanced rations, one being fed some 5 per cent or more in excess of the other.

Comparison with standards. Wolff ration.—The feeding tables in the appendix show that six of the seven cows ate on each ration more total dry matter, digestible dry matter, and of each of the three nutrients than the standard called for. Sue and Nancy B. ate no more protein, however, than standard amount. Goldie, who was getting old and whose teeth were poor, ate a ration very closely that of the standard. The other cows ate amounts of food which would have been sufficient for animals weighing from 100 to 200 pounds heavier. As a consequence all the cows increased in weight—page 256. *Wolff-Lehmann ration.*—Sue, Haidee and Eva ate all nutrients in excess of standard. Goldie's ration was closely standard. Atalanta, Nancy B and Acme 5th, three registered Ayrshires, all fresh at the outset of the tests, and each giving more milk daily than is scheduled

1 Thus, for example, the nutritive ratios of Sue's ration when eating mixed feed No. 2 varied from 1:5.4 to 1:5.6 (0.2 points).

by the highest Wolff-Lehmann standard, ate all the dry matter or more than the standard required, but less digestible protein and, in several periods, less digestible carbohydrates.[1]

Results.—As has been already remarked,—page 261—the data of these tests, although greatly condensed, is, notwithstanding, voluminous. As few figures as possible are given in the text. It is thought, however, that the scheme of tabulation is made clear by the captions of the tables and by the footnote on page 265.

The following table summarized from those at various points in the appendix shows the increase or decrease—expressed as percentages, total equaling 100—in dry matter eaten, in milk, total solids and fat given, and of products per 100 pounds of dry matter eaten, both in the total ration and in the experimental portions thereof, when a Buffalo gluten feed ration—nutritive ratios ranging from 1 : 5.2 to 1 : 6.0 and averaging 1 : 5.7—replaced a cottonseed-linseed ration—nutritive ratios ranging from 1 : 4.9 to 1 : 6.2 and averaging 1 . 5.6—or vice versa ; hay and silage being fed as roughages throughout.

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1 Inasmuch as no publication of this station for many years had given the standard rations, and, also, because of the recent issuance of the revision of the Wolff standard by Lehmann (Mentzel and Lengerke's Landw. Kalender, 1897) ; and since, likewise, this report meets the eyes of many who are not informed regarding standards, it seems proper to insert them for comparison. The Lehmann revision contemplates the variation of the standard ration roughly in proportion to the milk yield, apportioning more food to cows of greater milk-flow and less to those shrinking in yield, or of lighter milk-flow. It should be noted that they are based on the feeding of a cow weighing 1000 pounds and that the amounts of the nutrients prescribed are to be increased or decreased according to weight. In comparing the feeding of the cows in the tests now under discussion rough average weights and milk yields were struck and the standards taken most nearly agreeing therewith. Thus, for example, if a cow averaged 880 pounds weight and 20 pounds daily milk yield, the 900 pound live weight and 22 pound daily milk yield standard was used. It is proper to state that other standards have been proposed, but the ones here quoted, particularly the first, are most widely used.

POUNDS OF DIGESTIBLE NUTRIENTS PER DAY PER 1000 LBS. LIVE WEIGHT

	Dry matter	Digestible nutrients			Nutritive ratio
		Protein	Carbohydrates	Ether extract	
Wolff (German)	24.0	2.5	12.5	0.4	1:5.4
Wolff-Lehmann					
1. When giving 11 lbs. of milk	25.0	1.6	10.0	0.3	1:6.7
2. When giving 16½ lbs. of milk	27.0	2.0	11.0	0.4	1:6.0
3. When giving 22 lbs. of milk	29.0	2.5	13.0	0.5	1:5.7
4. When giving 27½ lbs. of milk	32.0	3.3	13.0	0.8	1:4.5

SUMMARY OF DIFFERENCE TABLES [1] (APPENDIX VI (*b*) AND VII)

I. TOTAL AND DIGESTIBLE FOOD AND DIGESTIBLE NUTRIENTS IN SLIGHT EXCESS IN BUFFALO GLUTEN RATION (SEVEN COWS)

RATIONS	Dry matter	Dry matter in experimental fodder	Quantity of milk	Total solids, per cent	Fat, per cent	Quantity of total solids	Quantity of fat	Product per 100 lbs. of dry matter: Entire ration: Milk	Entire ration: Total solids	Entire ration: Fat	Expermtl. fodder: Milk	Expermtl. fodder: Total solids	Expermtl. fodder: Fat	Ratio fat to solids-not-fat
(*a*) Buffalo ± cottonseed-linseed.....	+1	+13	+5	0	−2	+5	+4	+4	+4	+3	−9	−9	−10	
(*b*) Cottonseed-linseed ± Buffalo.	−2	−15	−8	+1	+2	−7	−5	−6	−5	−4	+6	+7	+8	
(*c*) 529 days' feeding on cottonseed-linseed ration ± 529 days feeding on Buffalo gluten ration.....	−1	−13	−6	+1	+2	−6	−5	−5	−4	−2	+8	+8	+9	−2

Conclusions.—It should be noted that (*a*) in the table indicates the percentage results when the Buffalo gluten ration was substituted for the cottonseed-linseed one; that (*b*) represents the outcome when the reverse was done, the cottonseed-linseed ration substituted for the gluten; and that (*c*) shows the percentage gain or loss resulting from 529 days feeding with the cottonseed-linseed ration instead of 529 days feeding on the gluten ration. These three comparisons were obtained with the same cows in the same series of tests. They are arrived at, however, in three different ways and they tell essentially the same story. The strict conclusion to be drawn from this table—which is typical of a large number following in this article—may be given as follows:

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1 This table, as well as another immediately following in this section of the discussion, p. 267, and nine others in the sections numbered from IV to X upon pages 272, 277, 278, 280, 281, 282, 284, 286, and 287, are so very condensed that, without further explanation, they may prove unintelligible. In the first place the reader is directed to the two pages of text at the end of the appendix explanatory of the difference tables. The nature of these tables and of their summaries given in the text of this article, is shown therein at length.

The tables printed with the discussions show the increase or decrease, as the case may be, in the weight of dry matter eaten, in the products given and in the production proportioned to 100 pounds of dry matter, when one ration replaced another. These increases and decreases are expressed as percentages, total equaling 100. Thus, for example, the total amounts of dry matter eaten by the 7 cows in the test now under discussion when fed the cottonseed-linseed ration was 6609.1 pounds, and when fed the Buffalo ration, 6699.3 pounds. The increase was 90.2 pounds, which is 1+ per cent of the weight of the dry matter eaten on the cottonseed-linseed ration. In other words, the figure 1, which appears at the beginning of the first table, is the "percentage" of increase, "total," (6609.1) "equaling 100" per cent. All the other figures in this and the similar tables further on were obtained in the same manner and have a like significance.

1. One per cent more total dry matter in the Buffalo ration than was eaten in the cottonseed-linseed ration produced from 4 to 5 per cent more milk, total solids and fat. (*a*)

2. One per cent less total dry matter in the cottonseed-linseed ration than was eaten in the Buffalo ration produced from 5 to 8 per cent less milk, total solids and fat. (*b*)

3. One per cent less total dry matter in the cottonseed-linseed ration than was eaten in the Buffalo ration produced from 5 to 6 per cent less milk, total solids and fat. (*c*)

This statement is exact and logical. It is the direct interpretation of the tabulated data into text; but it is rather confusing. Hence it is thought best to make the verbal conclusions less exact but not less correct as generalizations. This course will be taken with all the tabulations of this character in this article.

The outcome of these tests was as follows:

1. From 4 to 5 per cent the most milk, solids and fat were produced to the unit of dry matter when the Buffalo ration was fed.

2. The quality of the milk remained essentially unchanged. Such slight difference as was observed—0.10 per cent fat—was in favor of the gluten ration.

3. These two rations of equal balance but slightly unequal food consumption—5 per cent more total dry matter in the Buffalo ration—did not make equal amounts of milk and butter, both production and product per unit favoring the larger ration.

A discussion of the two rations used in this trial as to their relative worth as money makers will be found on pages 289 and 291.

2. TEST WITH WIDE NUTRITIVE RATIOS

Feeding.—Equal parts of corn and bran and Quaker oat feed were the variables in this trial. Both rations were readily eaten, 8 pounds of each grain being fed daily. Like amounts of digestible dry matter and protein were eaten on each ration. There was but 2 per cent shortage of digestible carbohydrates in one ration as compared with the other, and average nutritive ratios were identical. In no case was there more than 4 per cent difference in the amounts of dry matter consumed. In but one case was there more than this difference in digestible protein or carbohydrates eaten. From the experimental standpoint, so far as food consumption is concerned, this test was almost ideal.

Comparison with standards. Wolff ration.—All the cows ate total and digestible food enough to meet standard requirements for cows of 100 to 200 pounds heavier weight. Hence they gained weight—page 256. Because of the highly carbohydrate nature of both grain rations, from one-fourth to one-third too little digestible protein was eaten. *Wolff-Lehmann*

ration.—Golden Rod, Jersey Lily and Viola—the first two nearing stripping, the latter a two-year-old—ate more total and digestible food than the low standard calls for when the milk yield is relatively scanty. They even ate enough or nearly enough protein, notwithstanding the width of the ration. Jeannie and Clover, fresh in milk, ate enough digestible food, enough carbohydrates, but only one-half enough protein to meet the high requirements of the standard for deep milkers in the flush of flow. The last named cows ate more than enough digestible food if measured by the Wolff, but no excess measured by the revised standard.

Results.—The following table[1] summarized from those at various points in the appendix, show the increase or decrease—expressed as percentages, total equaling 100—in dry matter eaten, in milk, total solids and fat given, and of products per 100 pounds of dry matter eaten, both in the total ration and in the experimental portions thereof, when a Quaker oat feed ration—nutritive ratios ranging from 1:8.6 to 1:9.5 and averaging 1:8.9—replaced a corn and bran ration—nutritive ratios ranging from 1:8.2 to 1:9.3 and averaging 1:8.9—or vice versa; hay and silage being fed as roughages throughout.

SUMMARY OF DIFFERENCE TABLES (APPENDIX VI (*b*) AND VII)

I. TOTAL AND DIGESTIBLE FOOD AND NUTRIENTS EQUAL (FIVE COWS)

RATIONS	Dry matter	Dry matter in experimental fodder	Quantity of milk	Total solids, per cent	Fat, per cent	Quantity of total solids	Quantity of fat	Product per 100 lbs. of dry matter: Entire ration: Milk	Entire ration: Total solids	Entire ration: Fat	Experimtl. fodder: Milk	Experimtl. fodder: Total solids	Experimtl. fodder: Fat	Ratio of fat to solids-not-fat
(*a*) Quaker oat feed ± corn and bran.	+3	+3	+1	−1	+1	−1	0	−2	−4	−3	−2	−4	−3	
(*b*) Corn and bran ± Quaker oat feed.	−1	−1	−2	0	0	0	0	+4	+1	+1	+2	+2	+1	
(*c*) 118 days' feeding on oat feed ration ± 118 days' feeding on corn and bran	−2	−2	0	+1	0	+1	0	+2	+3	0	+2	+3	+2	+1

Conclusions.[2]—1. From 2 to 3 per cent less milk solids were produced to the unit of total dry matter when the Quaker oat feed was fed than when equal parts of corn and bran were used.

2. No alteration in the quality of the milk occurred as a result of the change in ration.

1 See foot note p. 265.

2 The remarks under the head "Conclusions" on pages 265-266 apply, with the necessary and obvious changes, to the dedutions to be drawn from this table.

3. These two rations of exactly equal balance and containing likewise equal amounts of digestible nutrients, were apparently of practically equal feeding value. A discussion of the relative worth of these two rations from the practical standpoint will be found on pages 290 and 292.

Three years' trials of this kind have now been made at this station, thirty-four cows have contributed their testimony and four different food combinations have been tried.

What is the outcome? Let us summarize.

1897. Nutritive ratios 1:6.3 and 1:7.3; equal amount of digestible protein in each ration; 6 per cent greater production on the ration with the least food but the narrower nutritive ratio.

1898. (*a*) Nutritive ratios 1:6.6 and 1:6.3; equal amounts of digestible carbohydrates in each ration; 6 per cent greater production on the wider ration, that containing the least food and 9 per cent less digestible protein.

(*b*) Nutritive ratios 1:6.1 and 1:6.3; digestible nutrients closely alike in each ration; 10 per cent greater production on the more palatable ration.

1899. (*a*) Nutritive ratios 1:5.6 and 1:5.7; 8 per cent more digestible protein and 6 per cent more digestible carbohydrates in one ration than in the other; 4 to 5 per cent greater production to a unit of dry matter from the ration containing the most food.

(*b*) Nutritive ratios, 1:8.9 and 1:8.9; equal amounts of digestible food and of each nutrient; equal production.

In weighing the results it is of much significance to note that the general trend of testimony in each test by each cow was always in the same direction, indicating some common cause and not idiosyncracy. In these five tests made with 34 cows, increased production followed the eating of more food once and less food twice, while on the same amount of food once there was 10 per cent increase in product and once no increase. Equal amounts of digestible protein and carbohydrates being fed, there occurred in successive years 6, 10 and 0 per cents increase on one ration as compared with another. In one case 6 per cent more product was made on 9 per cent less digestible protein, while in another 4 to 5 per cent more on 8 per cent more digestible protein. In one case 6 per cent more product followed the consumption of less digestible carbohydrates; in another case from 4 to 5 per cent more product was made when 6 per cent more of this nutrient was consumed.

There appears to be no uniformity, no safe ground to be held for theory or generalization in the outcome of these tests. It would seem that the question propounded at the opening of this discussion must be answered negatively. Uniform production is not to be expected of necessity when equal amounts of digestible nutrients derived from divers sources are eaten. The chemist and the digestion expert cannot tell the relative value of rations without the cow's aid. And, lastly, because she is the final arbiter, feed-

ing tests designed for the study of the productive values of different rations are still in order.

It is not unlikely that a primary cause for this seeming inequality is to be found in actual differences in the feeding value of nutrients at present grouped under the convenience terms protein and carbohydrates (nitrogen-free extract matter). For example, starch is in large measure separated in the manufacture of the gluten products and the carbohydrates of the Buffalo gluten feed are undoubtedly less starchy than those of mixed feed No. 2 against which it was fed. Similarly the Atlas ration, fed in the two years previous to this, was relatively deficient in starch. The agricultural chemist has still much to learn concerning the feeding values of the sundry nutrients.

IV. THE EFFECT UPON PRODUCTION OF THE ADDITION TO THE RATION OF EMULSIFIED OR UNEMULSIFIED FAT

At one time and another within the past ten years or more, accounts have been published touching the advisability of adding fat to a cow's ration as a means of improving the quality of the milk, or, as it has been expressed, "feeding fat into milk." Sundry fats including tallow, oleo, vegetable oils and the like have been used for this purpose. Publications on this subject have been made by Wing [1], Wood [2] and Bartlett [3] in this country; and by Stohmann [4], Soxhlet [5], Albert and Maercker [6], Beglarian [7], Rhodin [8], Winternitz [9] and Hagemann [10] in Europe. In most of these trials unemulsified fat was fed. Soxhlet has claimed, however, (*loc cit*) that provided the extraneous fat in the ration be in a form which admits of digestion, its addition thereto materially increases the fat content of milk, as was shown in his own work when emulsified sesame oil, linseed oil or tallow, thoroughly mixed with drinking water, were used. He concludes that similar tests with unemulsified fats which have resulted in no quality change, and which have hitherto been held to be strong arguments against the theory of food affecting the quality of milk are invalid, because the fats did not digest.

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1 N. Y. (Cornell) Sta. Bul. 92 (1895).
2 N. H. Sta. Buls. 16 (1892), 20 (1894).
3 Me. Sta. Rpt. 14. pp. 114-117 (1898).
4 Journ. f. Landw. II 4., pp. 166-172 (1869).
5 Wochenbl. Landw. Ver. Bayern 40 (1896); reviewed in Exp. Sta. Rec. 8, pp. 939, 1016-1019 (1897).
6 Landw. Jahrb. 27, p. 188-203 (1898).
7 Milch Zeit. 26, 33, pp. 522-523 (1897).
8 K. Landt. Okad Handl. 37. 1, pp. 25-33 (1898); also Milch Zeit. 27, pp. 306, 323 (1898).
9 Zeit. Physiol. Chem. 24, p. 425 (1898).
10 Landw. Jahrb. 28, 3-4, pp. 485-534 (1899).

Soxhlet cites but little data as to the conduct of the test, confining himself largely to theorizing and to discussion of results. Apparently the abnormal rations were fed but from 4 to 8 days, since these period lengths and no others are referred to in the article. Rhodin (*loc cit*) reports results of feeding emulsified oil for 3 to 4 weeks, and states that while the fat content was at first increased, it became normal again later on. Beglarian and, also, Hagemann (*loc cit*) report as the outcome of similar experiments in which they fed respectively for but brief periods emulsified linseed and sesame oils, that but slight or no change in quality ensued.

Extended investigation at this station[1] has shown the untrustworthiness of short feeding periods and disclosed the temporary nature of the marked changes in the quality of milk sometimes following decided changes in rations. The results of a careful survey of the more prominent feeding experiments indicating the possibility of increasing the fat percentage of milk by changes in feeding were given in our tenth report.[2] It was there stated that, because of the brevity of the feeding periods used, it was at least an open question in many cases whether the improvement was not a temporary change and the conclusions fallacious as to the effect of given rations. Notwithstanding these facts, the recognized eminence of Soxhlet, the plausibility of his theory as to the relation of the emulsifying process to the increase in fat percentage and the extreme importance of the claim—if true—impelled the writer to make a test of the matter.

Such a trial was made in the winter of 1897–98, using 4 cows. Circumstances arose which prevented the collation of the data in time for use in the last report.

A more extended trial was made during the past winter with 10 cows. Both series of tests are reported herewith.

Feeding.—Hay, silage and bran were fed as a uniform ration for three periods in the first test, and hay, silage and equal parts of corn and bran for five periods in the second. Raw cottonseed oil was added to the grain ration of two cows and emulsified cottonseed oil to that of the other two in the second feeding period of the earlier test. During the past winter emulsified oils were used, cottonseed oil being added to the grain ration of four cows, corn oil to that of three and linseed oil to that of three cows during the second and fourth feeding periods. In every case the oil was added gradually, beginning with one and two ounces to a feed and increasing this amount slowly through the preliminary portion of the period. After about ten days—the end of the preliminary and the beginning of the experimental portion of the period—and continuing to its end a pound and a half or more daily was given. The successive periods in the first test were 6, 6 and 5 weeks long; in the latter trial 5, 4, 6, 5 and 5 weeks long.

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1 Vt. Sta. Rpts. 10, pp. 146-161 (1897), 11, pp. 320-330 (1898).

2 Pp. 152-158.

The oils were emulsified by the long continued action of a jet of high-pressure steam. The completeness of the emulsion was proved in each case by examination with the microscope. The oil-saturated grain was distasteful to some of the cows and it was not relished by any. It was often but poorly eaten. It was impossible to estimate accurately from the orts the amounts of uneaten oil. In each case the assumption has been made—for working purposes—that all the oil was eaten, the entire grain orts being deducted from the grain, although containing some weight of oil.[1] The weights of oil given have entered into the calculation of total dry matter, but not into that of digestible dry matter or nutrients because of lack of knowledge as to their digestibility. On this account the data in the tables showing digestible ingredients eaten when the cows were upon this ration is not exact. It was evident from the consistency of the faeces that much of the oil passed the animals undigested. The cows in general in the earlier test—Red Top in particular—lost heavily in weight when fed the oil ration. In the latter test they tended to shrink somewhat in weight the first time oil was fed—largely, it is thought, because of uneaten grain—but gained weight during the second period of oil-feeding.

Comparison with standards. Wolff ration.—The cows in the earlier test ate more total and digestible food, but less protein, than the standard required. The shortage in this nutrient averaged one-fifth of standard amount. Digestible carbohydrates were with one exception eaten in plentiful amounts. Both total and digestible food were eaten in the latter test in amounts approximating or exceeding the standard requirements except during the first oil period. Eulalie, Rose, Lala and Dime in particular fell short of eating standard amounts at this time. The amounts of digestible protein eaten were uniformly low. *Wolff-Lehmann ration.*—The cows used in the earlier tests ate on the whole hardly as much total and digestible food as the standard called for. Protein consumption averaged two-fifths short of requirements. Digestible carbohydrates were generally eaten in standard amounts. In the latter tests total and digestible foods were eaten in amounts equalling or exceeding standard requirements. The amounts of digestible protein eaten were usually low; but the last four cows used, either because of very hearty eating or, in one case, because of the coincidence of a good appetite and a small flow of very rich milk sometimes met the protein requirements of the standard. Eulalie, Rose, Lala and Dime did not eat food enough during the first oil period to equal the standard. It should be

1. It would doubtless have been more nearly correct to have assumed that the amounts of oil and of grain in the so-called "meal orts" were proportioned to the amounts fed. Owing to the varying amounts of oil fed the calculations would have been burdensome and when attained undoubtedly inexact. It was thought best therefore to make the calculations as stated and to call attention to the facts.

remarked that in no case either year was any attempt made to feed a ration which should meet either standard.

Results.—The following table[1] is summarized from several different places in the appendix. It shows the increase or decrease—expressed as percentages, total equalling 100—in dry matter eaten, milk, total solids and fat given, and of products to the 100 pounds of dry matter when either (*a*) unemulsified cottonseed oil or, (*b*) emulsified cottonseed oil was added to bran—nutritive ratios ranging from 1:7.2 to 1:8.0 and averaging 1:7.6—; when (*c. d. e.*) emulsified cottonseed oil, or (*f. g. h.*) emulsified corn oil, or (*i. k. l.*) emulsified linseed oil was added to corn meal and bran—nutritive ratios ranging from 1:8.3 to 1:9.5 and averaging 1:9.0—were fed as compared with bran (*a* and *b*) or corn meal and bran (*c* to *l* inclusive)—nutritive ratios as above—without oil; hay and silage being fed as roughages in all cases.

SUMMARY OF DIFFERENCE TABLES, ETC., (APPENDIX VI (*b*) AND VII)

RATIONS	Dry matter	Quantity of milk	Total solids, per cent	Fat, per cent	Quantity of total solids	Quantity of fat	Product per 100 lbs of dry matter: Milk	Tot'l solids	Fat	Ratio of fat to solids-not-fat
(*a*) 46 days' feeding on unemulsified C. S. oil and bran ± 46 days on bran	+1	+5	+2	+7	+7	+13	+3	+5	+10	−8
(*b*) 46 days' feed on emulsified C. S. oil and bran ± 46 days on bran	+2	+8	0	+3	+6	+10	+4	+2	+5	−5
(*c*) Emul. C. S. oil and corn and bran ± corn and bran	+3	+6	0	+5	+6	+12	+10	+10	+17	....
(*d*) Corn and bran ± emul. C. S. oil, corn and bran	0	−6	0	−4	−5	−9	−7	−7	−11	....
(*e*) 126 days' feeding on emul. C. S. oil, corn and bran ± 126 days on corn and bran	−2	+6	0	+5	+5	+11	+9	+9	+15	−7
(*f*) Emul. corn oil, corn and bran ± corn and bran	−2	+3	−5	−7	−2	−2	+1	0	−1	....
(*g*) Corn and bran ± emul. corn oil, corn and bran	+5	−1	+6	+9	+4	+6	−3	−2	+1	....
(*h*) 126 days' on emul. corn oil, corn and bran ± 126 days on corn and bran	−3	+2	−6	−8	−3	−4	+6	+2	0	+3
(*i*) Emul. linseed oil, corn and bran + corn and bran	−5	0	−3	−4	−3	−4	+7	+3	+2	....
(*k*) Corn and bran ± emul. linseed oil, corn and bran	0	+1	+1	−1	+3	0	0	0	−2	....
(*l*) 126 days' feeding on emul. linseed oil, corn and bran ± 126 days on corn and bran	−3	0	−2	−2	−3	−3	+4	+1	0	−1

Conclusions.[2]—The outcome of two years trials may be expressed as follows:

1. *Unemulsified cottonseed oil* being fed with bran to two cows, the milk yield increased 3 per cent and that of solids and fat 5 and 10 per cent, respectively, to the unit of dry matter eaten.

1 See foot note p. 265. 2 See foot note 2, p. 267.

The quality of the milk was affected, the fat percentage rising 0.33 per cent and that of solids-not-fat dropping 0.10 per cent, a disproportionate increase (*a*).

2. *Emulsified cottonseed oil* being fed one season with bran to two cows and another year with corn meal and bran to four cows, the milk yield to the unit of dry matter eaten was increased 4 per cent one year and 9 per cent the other and that of total solids and of fat 2 and 5 per cent respectively one year and 9 and 15 per cent respectively the next year.

The quality of milk was affected each year, the fat percentages rising 0.12 per cent and 0.22 per cent while those of solids-not-fat dropped 0.18 per cent and 0.28 per cent, there being disproportionate increases of fat (*b.-e.*)

3. *Emulsified corn oil* being fed with corn meal and bran to three cows, the milk yield to the unit of dry matter eaten was increased about 3 per cent while those of total solids and fat remained unaffected.

The quality of milk was affected, the fat and solids-not-fat being depressed 0.41 and 0.42 per cents respectively, a very marked change and quite counter to that observed with the cottonseed oil. This is not a disproportionate change (*f.-h.*)

4. *Emulsified linseed oil* being fed with corn meal and bran to three cows, the milk yield to the unit of dry matter eaten was increased about 4 per cent and those of total solids about 2 per cent.

The quality of the milk was affected, the fat and solids-not-fat being depressed 0.09 and 0.26 per cent respectively. This is not a disproportionate change (*i.-l.*)

What effect did the continued feeding of oil have upon the fat content of the milk? Since constant sampling and analysis continued through the preliminary as well as through the experimental portions of the periods data is at hand to aid in answering this question.

The following table shows the average quality of the milk given on each ration during both the preliminary and the experimental portions of the periods.

COMPARISON OF QUALITY OF MILK GIVEN BEFORE AND AFTER THE COWS BECAME USED TO CHANGES IN RATIONS.

	No oil fed		Oil fed			No oil fed		Oil fed	
	Total solids %	Fat %	Total solids %	Fat %		Total solids %	Fat %	Total solids %	Fat %
Unemulsified C. S. oil					*Emulsified corn oil*				
Preliminary	13.14	4.51	13.30	4.76	Preliminary	14.66	5.07	15.36	5.79
Experimental	13.07	4.42	13.30	4.75	Experimental	15.16	5.48	14.26	4.98
Gain or loss from prolonged feeding	—0.07	—0.09	0	—0.01	Gain or loss from prolonged feeding	+0.50	+0.41	2 —1.10	2 —0.81
Emulsified C. S. oil (1898)									
Preliminary	13.75	4.79	13.98	4.99					
Experimental	[1] 13.93	4.91	13.70	4.82	*Emulsified linseed oil*				
Gain or loss from prolonged feeding	+0.18	+0.12	—0.28	—0.17					
					Preliminary	14.09	4.91	14.47	5.31
Emulsified C. S. oil (1899)					Experimental	14.29	5.05	14.12	5.03
					Gain or loss from prolonged feeding	+0.20	+0.14	—0.35	—0.28
Preliminary	13.71	4.50	14.54	5.24					
Experimental	14.16	4.81	14.29	5.11					
Gain or loss, etc	+0.45	+0.31	—0.25	—0.13					

In every case when emulsified oil was fed the quality of the milk given during the first ten days to two weeks was higher than that given during the 18 to 27 days following, when the animals had become more or less accustomed to their abnormal diet,—this too, notwithstanding the fact that during the earlier (preliminary) portion of the feeding period but little oil was fed while in the later (experimental) portion from three to four times as much oil was given each day.[3] This change was not noted when unemulsified oil was fed.

The figures on corn and bran are quite as decided the other way. The tendency of cows to give poorer milk on corn and bran when first changed

1 This figure and several others given in this table differ from the percentages as given in table VII in the appendix. These differences, mostly slight, arise from necessary variations in the method of calculation. Each set is correct for the place and the purpose for which it is used.

2 These extreme differences are due to the individuality of two cows, Annie and Ceres. Both ate the oil rations with reluctance, and the latter in particular gave milk of great richness and of most uneven quality.

3 It will be remembered that but an ounce or two a day was fed at the outset, this amount being gradually increased up to one and one-half pounds a day or more. This maximum was not attained until about or soon after the beginning of the experimental portion of the periods.

thereto from other rations has been noted heretofore.[1] It is thought that the differences in the present case are in part due to the return of the animals to normality after receiving an abnormal ration. Every time the feeding of emulsified cottonseed oil ceased and the use of the clear, unoiled grain ration was resumed a serious temporary decrease in the fat content of the milk occurred. The quality of the milk was thus lowered but once in nine times when the use of the other oils ceased.

The question now arises do these trials affirm or refute Soxhlet's assertion? Are they in agreement with Rhodin's or with Soxhlet's work? The use of all of the oils tended to increase the milk yield per unit of dry matter eaten. Cottonseed oil emulsified or raw seemed to cause a fairly permanent increase in the fat content of the milk ranging from 0.20 to 0.30 per cent. Emulsified corn and linseed oils seemed to cause a depression of the fat content when fed as a regular diet. Each and all when first fed in small quantities brought about marked gains in the fat percentages, but not later except when cottonseed oil was fed. This is most clearly seen by the comparison of the preliminary and the experimental portions of the periods, as shown in the last table.

GAINS IN FAT PERCENTAGE FROM THE ADDITION OF AN EMULSIFIED FAT TO A RATION

	Unemul. C. S. oil	Emul. C. S. oil (1898)	Emul. C. S. oil (1899)	Emul. corn oil	Emul. linseed oil
Preliminary	0.25	0.20	0.74	0.72	0.40
Experimental 2	0.33	—0.09 or +0.12	0.30 or 0.22	—0.50 or —0.41	—0.02 or —0.09

It is believed that the trials reported herewith are sufficiently extensive, bearing in mind Rhodin's results already cited, to warrant the denial of Soxhlet's claim and the assertion of a counter-claim as follows: While cottonseed oil emulsified or raw causes a slight and fairly permanent improvement in the quality of milk, emulsified corn and linseed oils do not. Since the raw cottonseed oil was as effective as the emulsified, it is fair to say that in our trials emulsifying oil was without influence as a means of feeding fat into milk.

To such as may be attracted by the increase in milk yield and quality resulting from feeding oil and contemplate its use it may be said that the injury to the quality of the butter resulting from this practise far outweighs any possible benefits from increased yield.[3]

Vt. Sta. Rpt. 10, pp. 159-160 (1897)

2 The figures in the upper line are taken from the table on page 274, those on the lower line from table VII in the appendix. In this connection see footnote 1 on page 274.

3 See Vt. Sta. Rpt. 11, p. 348; also later in this report.

V. THE RELATIVE FEEDING VALUES OF MEDIUM AND OF WIDE RATIONS

1. GRAIN RATIONS EQUAL IN AMOUNT

Comparisons of this sort are common. Considerable data in this line has been reported by this,[1] as well as by other stations.[2] The tests here cited add to our knowledge of this subject and compare two grain rations not hitherto tried against each other at this station, mixed feed No. 1 and Quaker oat feed.

Feeding.—Five cows were chosen, two well along in lactation, two fresh in milk, and one in medium flow. Hay was fed to all and silage to four as roughage. Eight pounds of grain were fed daily to each animal.

Comparison with standards. Wolff ration.—Four of the five cows ate total and digestible food in excess of standard requirements on both rations while Flora ate just enough to meet them. When on oat feed there was a deficiency of from one-quarter to one-half in digestible protein eaten. With the exception above noted the cows ate digestible food enough for animals from 100 to 200 pounds heavier weight. *Wolff-Lehmann ration.*—All the cows but Flora ate total and digestible food in excess of the standard but from one-quarter to one-half too little protein when on oat feed. Flora, however, fresh in milk and yielding heavily, ate far too little to meet the high requirements of the revised standard for deep milkers. Protein was one-third lacking in the medium and three-fifths lacking in the wide ration. This cow alone of all the herd seems to have eaten too little food throughout the trial. She lost seriously in weight, while her mates in this test gained—page 256.

Results.—The following table[3] summarized from those at various points in the appendix shows the increase or decrease—expressed as percentages, total equaling 100—of dry matter eaten, of milk, total solids and fat given, and of the same per 100 pounds of dry matter eaten, both in the total rations and in the experimental portions thereof, when a cottonseed-linseed ration (No. 1) of "medium" balance and fed in medium quantity—nutritive ratios ranging from 1:5.2 to1:6.5 and averaging 1:5.8—replaced a Quaker oat feed ration of "wide" balance and fed in medium quantities—nutritive ratios ranging from 1:8.6 to 1:9.5 and averaging 1:9.0—or vice-versa; hay and silage being fed as roughages throughout.

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1 Vt. Sta. Rpt. 6, pp. 143-153 (1892), Bul. 48, pp. 70-78 (1895), Rpt. 11, pp. 337-338 (1898).

2 Iowa Sta. Bul. 14, pp. 123-127 (1891); Me. Sta. Rpt. 9, pp. 83-82 (1893); Pa. Sta. Rpt (no vol.) pp. 56-74 (1895); Mass. State Sta. Rpt. 12, pp. 42-68 (1894); Mass. Hatch Sta. Rpt 9, pp. 100-125 (1897).

3 See foot note p. 265.

SUMMARY OF DIFFERENCE TABLES, ETC. (APPENDIX VI (*b*) AND VII)

RATIONS	Total dry matter eaten	Dry matter eaten in concentrates	Quantity of milk	Total solids, per cent	Fat, per cent	Quantity of total solids	Quantity of fat	Products per 100 pounds of dry matter: In entire ration: Milk	In entire ration: Total solids	In entire ration: Fat	In experimental fodder: Milk	In experimental fodder: Total solids	In experimental fodder: Fat	Ratio of fat to solids-not-fat
(*a*) Quaker oat feed ± mixed feed No. 1	+1	+4	−5	−1	−2	−6	−6	−6	−6	−7	−9	−9	−10	
(*b*) Mixed feed No. 1 ± Quaker oat feed	0	−1	+6	+1	+1	+7	+7	+6	+7	+7	+7	+8	+8	
(*c*) 118 days feeding on mixed feed No. 1 ± 118 days feeding on Quaker oat feed	−1	−3	+5	+1	+2	+6	+6	+6	+7	+7	+8	+9	+9	0

Conclusions[1].—1. The producing power of a unit of dry matter was 7 per cent greater when the mixed feed was used in place of the oat feed. The quality of the milk given on the mixed feed ration was slightly better than that yielded on oat feed, but the improvement was too small to be of practical importance.

This outcome is practically identical with that obtained last year. Viewed from the economical standpoint the better ration has proved the cheaper each year[2]. It cost the same to make a pound of butter on each ration, and the better one made more butter, more skimmilk and richer manure.

2. GRAIN RATIONS UNEQUAL IN AMOUNT

When two rations are fed one containing little and the other a fair amount of grain, the former of a wide and the latter a medium nutritive ratio, will production parallel food supplies or not? Naturally less milk will be given on the smaller ration, but may it not be made the cheaper?

The results of trials of the medium feeding of a medium ration—nutritive ratio, 1 : 6—and of relatively scant feeding, so far as grain is concerned, of a wide ration—nutritive ratio 1 : 12—were discussed in the last report.[3] A repetition of this test was carried out this year, using another concentrate in making up the richer ration and narrowing each somewhat.

Feeding.—Five cows, two two-year-olds, and three mature animals were fed hay, silage[4] and, in alternating periods, eight pounds of Buffalo gluten feed and two pounds corn meal with one pound bran.

1 See foot note p. 267.

2 Vt. Sta. Rpt. 11 pp. 341–342 (1898); also this report pp. 289, 291-292.

3 Vt. Sta. Rpt. 11, pp. 337-338 (1898).

4 Omitted with one cow.

Comparison with standards. Wolff ration.—Four of the five cows always ate more total and digestible food than the standard specified. They ate from one-third to one-half too little digestible protein when on the scant grain ration. One cow—Sylvia—ate more than the standard amount on the narrower and practically standard when fed the wide ration. Clearly the cows getting what was called the "scant" ration did not suffer for food, the scantiness being solely in the grain ration. *Wolff-Lehmann ration.*—The statements made under the Wolff ration heading apply equally well here.

Results.—The following table[1], summarized from those at various points in the appendix, shows the increase or decrease—expressed as percentages, total equaling 100—of dry matter eaten, of milk, total solids and fat given, and of same per 100 pounds of dry matter eaten when a Buffalo gluten ration of medium balance and fed in medium quantity—nutritive ratios ranging from 1:5.0 to 1:5.7 and averaging 1:5.5—replaced a corn (2 parts) and bran (1 part) ration (No. 5) of wide balance, the grain of which was fed in scant quantities—nutritive ratios ranging from 1:8 6 to 1:10.8 and averaging 1:9.7—or vice versa; hay and silage being fed as roughages throughout.

SUMMARY OF DIFFERENCE TABLES, ETC. (APPENDIX VI (*b*) AND VII)

RATIONS	Dry matter	Quantity of milk	Total solids, per cent	Fat, per cent	Quantity of total solids	Quantity of fat	Product per 100 pounds of dry matter			Ratio of fat to solids-not-fat
							Milk	Total solids	Fat	
(*a*) Buffalo gluten ± corn (2), bran (1)	+13	+17	−2	−6	+16	+14	+3	+4	0	
(*b*) Corn (2), bran (1) ± Buffalo gluten	−16	−26	+4	+8	−22	−18	−8	−5	−1	
(*c*) 276 days feeding on Buffalo gluten ± 276 days on corn (2), bran (1)	+16	+23	−3	−7	+21	+17	+6	+3	0	+6

Conclusions[2]—1. A unit of total dry matter in the medium ration made about 5 per cent more milk and 3 per cent more total solids than did the same amount in the wide ration.

2. The quality of the milk was decidedly and disproportionately affected. More and thinner milk was made on the heartier and less and richer milk on the lighter feed. The difference—0.40 per cent—is almost entirely located in the fat content and seems in part if not wholly involved in the causes referred to in the footnote on page 284. If the portions of the test other than period V be considered alone, the tendency is in the same

1 See foot note p. 265.

2 See foot note p. 267

direction but much less marked. Under the circumstances stress cannot be laid with safety on the result.

Two years' trials of this kind have been made. In the first trial dry matter consumption and production kept parallel in each ration; the more food proportionately the more milk. In the second test the narrower ration made from 3 to 5 per cent more product proportioned to food eaten. In one case a little better milk was made on the richer ration and in the other better milk on the poorer ration. Each year the practical dollars and cents outcome has favored the narrower ration,[1] although the gain has come solely from the increased value of skim milk and manure made on the higher feeding. It is of course doubtful whether cows would do as well on continuous scant feeding, and it should be remembered that they all ate very heartily of roughages, thus getting more total food than the standards require.

VI. THE FEEDING VALUE OF BUCKWHEAT MIDDLINGS

Buckwheat middlings are quite variable in composition. If fairly free from hulls they rank well up with linseed meal in protein content; but in proportion as the hulls enter into their composition their value is lessened. Their value as a milk-maker is not well established, many dairymen esteeming them and others looking askance at them.

Feeding.—Trials were made comparing buckwheat middlings with the cottonseed, linseed, corn and bran mixtures—Nos. 1 and 2—and with corn and bran. In most of these trials mixed feed No. 3 (4 parts buckwheat middlings, 3 parts bran and 1 part corn) were used. In one trial clear middlings were fed. Six cows were used, one two year old, two three year olds and three mature animals.

Comparison with standards. Wolff ration.—The writer knows of no digestion experiments with buckwheat middlings, and no computation of digestible nutrients eaten can be made when these were fed. The cows ate as much total dry matter when the buckwheat ration was in use as when the other grain feeds were fed, and probably there was not great difference in the amount of digestible food eaten. Four of the cows ate an excess over standard requirements, while two—Salida and Maizie—ate just standard amounts—barring slight shortage in protein. *Wolff-Lehmann ration.*—Five of the cows ate more than this standard calls for; one—Maizie—did not quite reach it. Such cows as ate corn and bran did not reach either standard in digestible protein.

Results.—These tests are grouped in two tables, the first showing the outcome when the closely similar cottonseed-linseed mixtures were fed, the second where corn and bran were used.

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1 Vt. Sta. Rpt. 11, p. 341-342; also this report, pp. 289, 291.

The following table,[1] summarized from various points in the appendix, shows the increase or decrease—expressed as percentages, total equaling 100—in dry matter eaten, milk, total solids and fat given, and of products per 100 pounds of dry matter, when grain mixtures containing corn meal, wheat bran, cottonseed and linseed meals—nutritive ratios ranging from 1:4.6 to 1:6.1 and averaging 1:5.4—were fed in place of those containing buckwheat middlings, corn meal and wheat bran, or vice versa; hay and silage being fed as roughages throughout.

SUMMARY OF DIFFERENCE TABLES. (APPENDIX VI (*b*) AND VII)

RATIONS	Total dry matter eaten	Dry matter eaten in concentrates	Quantity of milk	Total solids, per cent	Fat, per cent	Quantity of total solids	Quantity of fat	Products per 100 pounds of dry matter: In entire ration: Milk	In entire ration: Total solids	In entire ration: Fat	In experimental fodder: Milk	In experimental fodder: Total solids	In experimental fodder: Fat	Ratio of fat to solids-not-fat
(*a*) Mixed feed No. 3 ± mixed feed No. 1	0	+3	−3	+1	+2	−3	−2	−3	−3	−2	−7	−6	−5	
(*b*) Mixed feed No. 1 ± mixed feed No. 3	−5	−15	−6	+4	+5	−2	−1	−1	+3	+4	+8	+11	+12	
(*c*) 82 days on mixed feed No. 3 ± 82 days on mixed feed No. 1	−1	−6	+1	0	0	+1	+1	+2	+3	+2	+7	+7	+7	+1
(*d*) Mixed feed No. 3 ± mixed feed No. 2	+6	+15	+5	+2	+4	+7	+10	−1	0	+3	−11	−9	−6	
(*e*) Mixed feed No. 2 ± mixed feed No. 3	−7	−14	0	+2	−1	+3	0	+2	+9	+6	+12	+14	+12	
(*f*) 46 days on mixed feed No. 2 ± 46 days on mixed feed No 3	−7	−13	−2	0	−3	−2	−5	+4	+4	+3	+12	+13	+10	+5

The following table[1] summarized from various points in the appendix shows the increase or decrease—expressed as percentages, total equaling 100—in dry matter eaten, milk, total solids, and fat given, and of products per 100 pounds of dry matter, when grain rations containing corn meal and wheat bran—nutritive ratios ranging from 1:8.5 to 1;9.3 and averaging 1:9.0—were fed in place of grain mixtures containing buckwheat middlings, corn meal and wheat bran, or buckwheat middlings only, or vice versa; hay and silage being fed as roughages throughout.

[1] See foot note, p 265.

SUMMARY OF DIFFERENCE TABLES. (APPENDIX VI (*b*) AND VII)

RATIONS	Total dry matter eaten	Dry matter eaten in concentrates	Quantity of milk	Total solids, per cent	Fat, per cent	Quantity of total solids	Quantity of fat	Products per 100 pounds of dry matter: In entire ration: Milk	In entire ration: Total solids	In entire ration: Fat	In experimental fodder: Milk	In experimental fodder: Total solids	In experimental fodder: Fat	Ratio of fat to solids-not-fat
(*a*) Mixed feed No. 3 ± corn and bran	−2	0	+1	0	0	+1	+2	+2	+2	+3	0	0	+1	
(*b*) Corn and bran ± mixed feed No. 3	+1	0	−4	−1	0	−5	−4	−5	−6	−5	−4	−4	−3	
(*c*) 54 days feeding on corn and bran ± 54 days feeding on mixed feed No. 3	+1	−2	−2	0	0	−2	−2	−3	−4	−4	−1	−2	−2	0
(*d*) Buckwheat middlings ± corn and bran	+3	−4	+4	+1	+8	+5	+12	0	+1	+8	+8	+8	+15	
(*e*) 18 days feeding on corn and bran ± 18 days feeding on buckwheat middlings	−3	+4	−4	−1	−8	−5	−12	−3	−1	−11	−7	−8	−15	+12

Conclusions[1].—1. A unit of dry matter in the cottonseed-linseed mixture produced about 3 per cent more milk, total solids and fat than in the buckwheat middlings mixture.

2. A unit of dry matter in the buckwheat middlings mixture produced about 4 per cent more milk and its products than in the corn and bran ration.

3. The quality of the milk on the different rations remained essentially unchanged with two exceptions. One cow fed feed No. 1 and the middlings ration showed alteration as did likewise the one cow fed clear middlings. Neither result is thought to be beyond criticism. In the first case other cows similarly fed did not alter the quality of their milk. In the other case the milk seemed to be disproportionately affected by feeding clear buckwheat middlings. This apparent result depends upon but a single period's feeding of one cow and upon but three composite samples, others being omitted through error. Moreover one of these samples includes the milk of one day when the cow was off feed and dropped one-half in milk yield. The result is not entitled to great weight unless confirmed by further work.

Hayward and Weld[2] report that buckwheat middlings, brewers' grains and cerealine feed have essentially equal feeding values.

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1 See foot note p. 267.

2 Pa. Sta. Rpt. (no vol.) pp. 51-64 (1897).

A discussion of the economic values of these several rations will be found on pages 290–292.

Experiments in clear buckwheat middling feeding are scheduled for the coming winter.

VII. THE FEEDING VALUE OF ARTICHOKES

Some two years ago the "Improved french white artichoke" was grown in this vicinity and a considerable sale of tubers was made in the springs of 1898 and 1899 for seed. The station grew the crop during the season of 1898, and extensive feeding trials were planned to test its value as a food for cows. It is claimed that both top and tuber are readily eaten by all sorts of farm live stock. The crop was cut about November 1, the stalks being in good condition and but slightly frost bitten.

Feeding.—None of the many cows in our herd to which the stalks were fed would eat them in sufficient quantities to make the results of value. Consequently the cows scheduled in this portion of the experiment were transferred to other tests about January 1.

The tubers were fed to several cows. This part of the test progressed nicely, but was almost entirely ruined by erroneous estimates as to the supply of tubers on hand. In addition to this misfortune a serious error in feeding rendered useless the records of two cows. Out of this wreck but a single comparison with one cow remains.

Results.—The following table[1], summarized from the appendix, shows the increase or decrease—expressed as percentages, total equaling 100—in dry matter eaten, milk, total solids, and fat given, and of products per 100 pounds of dry matter, when artichokes were fed instead of silage; nutritive ratios, silage ration, 1:9.2; artichoke ration, 1:8.3; hay, corn and bran being fed throughout.

SUMMARY OF DIFFERENCE TABLES. (APPENDIX VI (*b*) AND VII)

RATIONS	Total dry matter	Quantity of milk	Total solids, per cent	Fat, per cent	Quantity of total solids	Quantity of fat	Product per 100 pounds of dry matter			Ratio of fat to solids-not-fat
							Milk	Total solids	Fat	
18 days feeding on silage ± 18 days on artichokes	+8	−4	−1	+2	−5	−2	−11	−12	−8	−4

Conclusions.[2]—The outcome of this fragmentary test is as follows:

1. Although 8 per cent more total dry matter was eaten in the silage ration than in the artichoke ration 4 per cent less product was made.

1 See foot note p. 265. 2 See foot note p. 267.

2. To the unit of dry matter 10 per cent less milk, total solids and fat were made on the silage than on the artichoke ration.

3. The quality of the milk was essentially unaltered.

Although on the face of it artichokes seem to have a higher feeding value than silage, the evidence adduced is too slight in quantity to warrant emphasis.

The results of a careful chemical study of the artichoke plant will be published in the near future.

VIII. WATERING AT WILL AND AT STATED INTERVALS

Does an increase in milk yield and butter production accrue if cows may drink water whenever they wish instead of twice a day, provided in each case they get an apparent sufficiency?

Feeding.—Four cows, two 2-year-olds and two mature animals were fed hay, silage and equal parts corn and bran for three 4-week periods, being treated similarly throughout save that in alternating periods they drank water whenever they wished or only at intervals. In the former case the water was kept in buckets in the mangers and supplied as fast as drunk; in the latter case the cows were watered twice daily in the yard, drinking as much as they wished each time.

Comparison with standards. Wolff ration.—All four cows ate more total and digestible dry matter and carbohydrates than the standard requires but from a sixth to a third less protein. They ate food equivalent to the standard wants of cows of 150 to 250 pounds greater weight and hence all laid on flesh. *Wolff-Lehmann ration.*—The remarks under Wolff ration are applicable to comparison with the revised one, save that from an eighth more to but half as much protein as standard calls for was eaten.

Results.—The following table[1] summarized from those at various points in the appendix shows the increase or decrease—expressed as percentages, total equaling 100—in dry matter eaten, in milk, total solids and fat given, and of products per 100 pounds of dry matter eaten, both in the total ration and in the experimental portions thereof when watering at will was followed instead of watering at stated intervals or vice versa; hay and silage as roughages and corn and bran as concentrates being fed throughout, nutritive ratios ranging from 1:8.5 to 1:9.4 and averaging 1:9.0.

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1 See foot note p. 265.

SUMMARY OF DIFFERENCE TABLES (APPENDIX VI (*b*) AND VII)

RATIONS	Dry matter	Dry matter in experimental fodder (grain)	Quantity of milk	Total solids, per cent	Fat, per cent	Quantity of total solids	Quantity of fat	Products per 100 lbs. of dry matter. In entire ration: Milk	Total solids	Fat	Ration of fat to solids not-fat
(*a*) Water at will ± water at intervals..	+1	+2	+3	−4	−6	−1	−2	+2	−2	−3	
(*b*) Water at intervals ± water at will .	−2	−3	−4	+5	+7	+2	+3	−3	+3	+3	
(*c*) 126 days' feeding, water being given at intervals ± 126 days' feeding, water being available at will.....	−1	−3	−3	+5	+6	+1	+2	−2	+1	+5	−2

Conclusions[1].—1. A unit of dry matter eaten when the cows drank at will produced 2 per cent more milk than when watered at intervals, a result so small as to be hardly beyond the range of experimental error.

2. The quality of the milk varied widely, that given when the cows were watered in their stanchions being notably poorer than that given when they were watered in the yard. The change is marked both in fat and in solids-not-fat. It is thought that this result does not represent the facts as to the effect of changes in systems of watering cows upon quality of milk and no stress is laid upon it[2].

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1 See foot note p. 267.

2 A survey of the analytical data of the entire winter and for all the cows under experiment discloses the fact that the average analyses of the milk given during the experimental portions of periods VI—four-week—and V—five-week—being respectively March 24 to April 11 and March 26 to April 18, are in rather more than three-fourths the cases notably higher—0.30 per cent or more total solids—and in most of the remainder somewhat higher than the analyses for the periods on either side of these dates. Since this improvement in quality is true of the herd as a whole and is not accompanied by a shrinkage in milk yield, it is clearly due to some common cause. Coincident with the beginning of these experimental periods temporary changes were made in the employees sampling and analyzing the milk. The relatively high figures continued, however, for a longer time after the return of the regular men to their duties than than they had during their absence. It should be remarked, moreover, that the substitute analyst is a notably expert operator. It is not probable that errors in sampling and analysis are important factors in this result. This conclusion has been reached after a most thorough scrutiny of the data and inquiry as to the circumstances connected with the conduct of the sampling and analytical operations. No rational explanation for this marked quality change has been discovered. Nothing like it has occurred hitherto at this station.

Attention is called to the fact that this disturbing factor, whatever its origin, is rendered harmless so far as the trials are concerned whenever feeding periods alternated, i. e., when approximately as many cows were being fed on one ration as on another at the same time. Its ill effect is likewise minimized when five or six feeding periods were used. In certain tests, however,—and notably in the one now under discussion—the value and, probably, the trustworthiness of the results are seriously lessened by this unfortunate occurrence.

Backhaus[1] reports an increase of about one pound daily in milk yield without decrease in solids or fat content following a change from watering twice daily to a constant water supply. This is a larger gain than found in our tests. The experiment is to be repeated at this station during the coming winter.

IX. THE GROOMING OF COWS

Does the carding of cows add to the milk and butter yields or only to the cleanliness of animal and product?

It is well known that the likelihood of a high grade butter being made from a herd kept in cleanly fashion is greater than if the cows be kept in the ordinary manner. The possibilities of greater milk yield as a result of the animal's increased physical comfort and sense of decency are also worthy of consideration.

Feeding.—A test of this matter was made with five cows, two 2-year-olds and three mature animals. All were fed hay and silage; three ate mixed feed Nos. 1, and two, equal parts corn and bran. The rations were uniform throughout the trials but in alternating periods the cows were carded or left ungroomed. It is but fair to say, however, that even when left uncarded the animals were far cleaner than cows as they are too commonly kept.

Comparison with standards. Wolff ration.—Excessive amounts of all nutrients were eaten by the cows getting the mixed feed, enough total food but too little protein by the cows eating corn and bran. The cows ate food enough for animals 100 to 200 pounds heavier and hence increased in live weight. *Wolff-Lehmann ration.*—All nutrients in all cases were eaten in amounts equal to or greater than standard requirements.

Results.—The following table[2] summarized from those at various points in the appendix shows the increase or decrease—expressed as percentages, total equaling 100—in dry matter eaten, milk, total solids, and fat given, and of products per 100 pounds of dry matter, when the cows were groomed as compared with times when left uncarded; hay and silages as roughages and either mixed feed No. 1 or corn and bran as concentrates being fed throughout, nutritive ratios ranging from 1:4.9 to 1:6.1 and from 1:8.6 to 1:9.3 and averaging 1:5.5 and 1:9.0.

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1 Milch Zeit., 21 pp. 509-512 (1892); Ber. Landw. Inst. Univ. Königsberg 2, pp. 34, (1897).

2 See foot note p. 265.

SUMMARY OF DIFFERENCE TABLES, ETC. (APPENDIX VI (*b*) AND VII)

RATIONS	Dry matter	Dry matter in experimental fodder (grain)	Quantity of milk	Total solids, per cent	Fat, per cent	Quantity of total solids	Quantity of fat.	Product per 100 pounds of dry matter			Ratio of fat to solids-not-fat
								Milk	Total solids	Fat	
(*a*) Groomed ± not groomed	0	−1	−1	+4	+5	+3	+4	−1	−3	−3	
(*b*) Not groomed ± groomed	+2	0	+1	+2	+4	+3	+4	−2	0	+2	
(*c*) 90 days not groomed ± 90 days groomed	+1	+1	+1	−2	−2	−1	−1	0	−2	−2	+1

Conclusions.[1]—1. A unit of total dry matter yielded practically the same product whether the cows were groomed or not.

2. The quality of the milk given by the cows when groomed was slightly better than that given when not carded, but the difference was too small to be of importance.

Backhaus[2] reports from 2.5 to 8 per cent increase in yield of milk following grooming.

It is expected to keep the cows used in a repetition of this test while uncarded more nearly under the common conditions of relative uncleanliness.

X. EXPERIMENTAL ERROR IN FEEDING TESTS

It has happened each winter for several years that two or more of the station cows have been fed an unchanged ration throughout the season. Since the food and milk of such cows are weighed, sampled and analyzed in the same manner and with similar thoroughness as with other cows there yearly accumulates data for study of this question.

Feeding.—The records of four cows, one two-year-old and three mature animals are at hand this year. Brownie was fed hay, corn and bran, Rachel, the same with silage, Star Bright, hay, silage and Buffalo gluten feed and Max Belle, hay, silage and mixed feed No. 2. Nine comparisons are available.

Comparison with standards. Wolff ration.—Star Bright and Max Belle ate all nutrients in excess of requirement, Rachel more digestible food but less protein than standard called for, while Brownie seems to have been rather underfed. She gave, however, but little milk. *Wolff-Lehmann ration.*—Star Bright and Max Belle ate food closely standard in amount and character, Rachel more digestible food and less protein than standard and Brownie was decidedly underfed.

1 See foot note p. 267.

2 Jour. f. Landw. 41, p. 332 (1893).

Results.—The following table[1] summarized from those at various points in the appendix shows the increase and decrease—expressed as percentages, total equaling 100—in dry matter eaten, in milk, total solids and fat given and of products per 100 pounds of dry matter both in the total and in the experimental portions of the ration, upon uniform rations, fed in 5-week periods. The three upper lines show differences in percentages, the latter three, the results of 69, 46 and 92 days feeding.

SUMMARY OF DIFFERENCE TABLES, ETC. (APPENDIX VI (*b*) AND VII)

Rations	Total dry matter eaten	Dry matter eaten in concentrates (grain)	Quantity of milk	Total solids, per cent	Fat, per cent	Quantity of total solids	Quantity of fat	Products per 100 pounds of dry matter: In entire ration: Milk	In entire ration: Total solids	In entire ration: Fat	In experimental fodder (grain): Milk	In experimental fodder (grain): Total solids	In experimental fodder (grain): Fat	Ratio of fat to solids-not-fat
Corn and bran	+1	+1	−1	+1	+1	0	0	0	+1	+3	−2	−1	0	
Buffalo gluten	−1	+1	+4	−3	−4	+1	0	+5	+1	+2	+3	−2	−1	
M. F. No. 2...	−2	+1	+1	−1	+2	0	0	+4	+2	+3	+1	−1	−1	
Corn and bran	+1	+1	−1	+1	+1	0	0	0	+1	+3	−2	−1	0	−1
Buffalo gluten	−1	+1	+4	−3	−4	+1	0	+5	+1	+2	+3	−2	−1	+2
M. F. No. 2...	−2	+1	+1	−1	−2	0	0	+4	+2	+3	+1	−1	−1	+1

Conclusions.[2]—1. A unit of dry matter produced as much milk, total solids and fat at one time as another, lactation stages being equalized.

2. Quality remained essentially unchanged.

Of the 54 figures showing production and effect thereon 13 are zeros, 19 ones and 7 twos, or nearly three-quarters of the entire number.

Repeated trials of this nature serve but to confirm the statement made three years ago[3], that "apparently if the animals for feeding tests are carefully selected, and a sufficient number are used, the 'experimental error' may be nearly disregarded. If but two or three animals are used, it will hardly be safe to assert dogmatically that fluctuations of the product are of necessity due to changes in the character of the feeding, unless they exceed 4 or 5 per cent of the larger product."

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1 See foot note p. 265.

2 See foot note p. 267.

3 Vt. Sta. Rpt. 9, p. 228 (1895)

XI. RELATIVE VALUES OF VARIOUS GRAIN RATIONS

A study of the financial side of the present series of tests furnishes much valuable information touching the relative worth of the various grain rations.

The following tables show:

1. The weights of the various fodders and feeds eaten.
2. The weights of milk and butter produced.
3. The money value[1] of the food eaten.
4. The cost of food for 100 pounds of milk and for 1 pound of butter.
5. Proceeds for butter at 20 cents a pound.
6. The fertilizing value[2] of the rations.
7. The total value of all production, butter, skim milk and two-thirds of fertilizing ingredients.
8. Gain, net gain, and daily net gain of one ration over another.

These are shown for the experimental portions of the periods only. Lactation stages are exactly equalled by calculation; hence each ration has the same chance as its rival to prove its worth.

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1 Hay $9, corn meal $17, bran $15, cottonseed meal $23, linseed meal $27.50, Buffalo gluten feed $19, buckwheat middlings $18, Quaker oat feed $16.50, silage $3; average market price for grain feeds, and average estimates of many prominent and successful farmers in various portions of the state of the money values of hay and silage at the barn ready for feeding.

2. Nitrogen 14 cents, phosphoric acid 4 cents, potash 4¼ cents; 1898 and 1899 trade values for the same ingredients of essentially similar availability in commercial fertilizers

COMPARATIVE VALUES OF VARIOUS RATIONS FROM THE FINANCIAL STANDPOINT

RATIONS	Hay	Corn meal	Wheat bran	½ cottonseed, ½ linseed	Buffalo gluten or Quaker oat feed	Silage	Milk	Butter	Money value of food	Cost of food for: 100 lbs. of milk	Cost of food for: 1 lb. butter	Proceeds for butter at 20 cents	Fertilizing value of food eaten
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	$	cts.	cts.	$	$
529 DAYS ON BUFFALO GLUTEN FEED (8 LBS. DAILY) VS. 529 DAYS ON COTTONSEED, LINSEED, CORN AND BRAN (7 LBS. DAILY)													
Buffalo gluten	7431	....	....	....	4206	12305	12491	686	91.86	73.5	13.4	137.20	57.59
Cottonseed, etc.	7747	528	1585	1585		12415	11699	653	89.87	76.8	13.8	130.60	57.48
Difference in favor of gluten							+ 792	+ 33	+ 1.99	— 3.3	— 0.4	+ 6.60	+ 0.11
P'rc'ntage difference							+ 6	+ 5	+ 2	— 4	— 3	+ 5	0
276 DAYS ON BUFFALO GLUTEN FEED VS. 276 DAYS ON TWO PARTS CORN, 1 PART BRAN (8 LBS. A DAY, FIRST RATION, 3 LBS. A DAY, SECOND RATION)													
Buffalo gluten	5397	....	....	....	2116	1915	4435	282	47.27	106.6	16.8	56.40	30.33
Corn (2) bran (1)	5646	554	277	....		1928	3604	242	35.09	97.4	14.5	48.40	20.37
Difference in favor of gluten							+ 831	+ 40	+ 12.18	+ 9.2	+ 2 3	+ 8.00	+ 9.96
P'rc'ntage diff'r'nce							+ 19	+ 14	+ 26	+ 9	+ 14	+ 14	+ 33
118 DAYS ON QUAKER OAT FEED VS. 118 DAYS ON COTTONSEED, LINSEED, CORN AND BRAN (8 LBS. A DAY EACH RATION)													
Quaker oat feed	1638	....	....	....	941	2360	2306	141	18.67	81.0	13.2	28.20	8.81
Cottonseed, etc.	1658	233	350	350	....	2365	2423	150	20.02	82.6	13.3	30.00	12.52
Difference in favor of cottonseed, etc.							+ 117	+ 9	+ 1.35	+ 1.6	+ 0.1	+ 1.80	+ 3.71
P'rc'ntage diff'r'nce							+ 5	+ 6	+ 7	+ 2	+ 1	+ 6	+ 42

Total value of butter, skimmilk and two-thirds of fertilizing ingredients; Buffalo gluten ration, $196.99, cottonseed-linseed ration, $188.95.

Difference in favor of Buffalo gluten ration, $8.04.

Gain, ($8.04), less extra cost. ($1.99), gives net gain, $6.05; daily net gain, 1.14 cents.

Total value of butter, skimmilk and two-thirds of fertilizing ingredients; Buffalo gluten ration, $84.22, corn (2) bran (1) ration, $68.18.

Difference in favor of Buffalo gluten ration, $16.04.

Gain, ($16.04), less cost, ($12.18), gives net gain, $3.86; daily net gain, 1.40 cents.

Total value of butter, skimmilk and two-thirds of fertilizing ingredients; Quaker oat feed ration, $38.07, cottonseed-linseed ration, $42.54.

Difference in favor of cottonseed-linseed ration, $4.77.

Gain, ($4.77), less extra cost, ($1.35), gives net gain, $3.12; daily net gain, 2.64 cents.

RATIONS	Hay	Corn meal	Wheat bran	½ cottonseed ½ linseed	Quaker oat feed or buckwheat middlings	Silage	Milk	Butter	Money value of food	Cost of food for 100 lbs. of milk	Cost of food for 1 lb. butter	Proceeds for butter at 20 cents	Fertilizing value of food eaten
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs	$	cts.	cts.	$	$

118 DAYS ON QUAKER OAT FEED VS. 118 DAYS OF EQUAL PARTS CORN AND BRAN (6 OR 8 LBS A DAY EACH RATION)

Quaker oat feed	1533	....	....	....	847	1988	2091	128	16.87	80.7	13.2	25.60	8.34
Corn and bran	1519	426	426	....	....	1637	2094	128	16.56	79.1	12.9	25.60	9.00
Difference in favor of corn and bran, etc							+ 3	0	— 0.31	—1.6	—0.3	0	+ 0.66
P'rc'ntage diff'r'nce							0	0	— 2	— 2	— 2	0	+ 8

Total value of butter, skimmilk and two-thirds of fertilizing ingredients; Quaker oat feed ration, $34.76, corn and bran (equal parts) ration, $35.20.

Difference in favor of corn and bran ration, $0.44.

Gain, ($0.44), plus lessened cost ($0.31) gives net gain, $0.75; daily net gain, $0.64 cents.

128 DAYS ON BUCKWHEAT MIDDLINGS, CORN AND BRAN VS. 128 DAYS ON COTTONSEED, LINSEED, CORN AND BRAN (8 LBS. A DAY EACH RATION)

Buckwheat mid. etc.	1795	127	379	....	505	1359	2444	134	18.59	76.1	13.9	26.80	11.21
Cottonseed, etc.	1814	198	366	361		1319	2442	133	19.11	78.3	14 4	26.60	12.26
Difference in favor of cottonseed, etc.							— 2	— 1	+ 0.52	+2.2	+0.5	— 0.20	+ 1.05
P'rc'ntage diff'r'nce							0	— 1	+ 3	+ 3	+ 4	— 1	+ 10

Total value of butter, skimmilk and two-thirds of fertilizing ingredients; buckwheat middlings ration, $38.48, cottonseed-linseed ration, $38.99.

Difference in favor of cottonseed-linseed ration, $0.50.

Gain, ($0.50), less extra cost ($0.52), gives net loss $0.02.

72 DAYS ON BUCKWHEAT MIDDLINGS, CORN AND BRAN VS. 72 DAYS ON EQUAL PARTS CORN AND BRAN (8 LBS. A DAY EACH RATION)

Buckwheat mid. etc.	1118	54	162	....	355	1076	1797	95	11.51	64.1	12.1	19.00	6.97
Corn and bran	1133	288	288	....	....	1079	1759	91	11.33	64.4	12.4	18.20	6.19
Difference in favor of buckwheat, etc.							+ 38	+ 4	+ 0.18	—0.3	—0.3	+ 0.80	+ 0.78
P'rc'ntage difference							+ 2	+ 4	2	0	— 2	+ 4	+ 11

Total value of butter, skimmilk and two-thirds of fertilizing ingredients; buckwheat middlings ration, $26.65, corn and bran (equal parts) ration, $25.33.

Difference in favor of buckwheat middlings ration, $1.32

Gain, ($1.32). less extra cost ($0.18) gives net gain $1.14; daily net gain, 1.58 cents.

1. It appears from the table on the preceding page that the cottonseed-linseed ration, fed 529 days, cost 2 per cent less than the Buffalo gluten feed ration fed the same length of time. It made 6 per cent less milk and 5 per cent less butter. It cost 4 per cent more to make a pound of milk and 3 per cent more to make a pound of butter from the cottonseed-linseed than from the gluten ration. The former cost less than the latter; but the more costly ration was much the cheaper since the extra outlay for food of $1.99 in the gluten ration was followed by the production of butter worth $6.60 more, of about 700 pounds more of skim milk and of additional fertilizing ingredients "valuing" $0.11. Just how much of the latter may reach the soil depends on several factors. It is conservative to allow two-third as ultimately available. Allowing 20 cents a hundred for skim milk—its feeding value in our more recent experiments—the total gain amounts to $8.04, which, less $1.99, leaves net gain $6.05, daily net gain 1.14 cents.

2. The 2 parts corn, 1 part bran ration, fed 276 days, cost 26 per cent less than did the Buffalo ration, fed for the same length of time. It made 19 per cent less milk and 14 per cent less butter. It cost 9 per cent less to make a pound of milk and 14 per cent less to make a pound of butter from the corn and bran than from the gluten feed ration. The former cost less than the latter, yet the more costly ration was really the cheaper since the extra outlay for food of $12.18 in the gluten ration entailed an added production of $8.00 worth of butter, about 700 pounds more skim milk and additional fertilizing ingredients "valuing" at $9.96. Using the assumption as before, the total gain amounts to $16.04, which lessened by $12.18, leaves net gain $3.86—daily net gain 1.40 cents. This gain was derived solely from the skim milk and manure, since the extra amount of butter made was not worth the increase in the cost of the grain. At first thought this outcome seems rather favorable to the practice of feeding grain in scant rather than in medium quantities. As a matter of fact, however, the cows fed thus scantily lost in weight and probably were converting flesh into milk. Moreover there may have been some residual effect of rations fed in previous periods, notwithstanding the intervention of the 12-day preliminary portions of the periods. If so the corn and bran figures would be raised and the gluten data lowered. It may be doubted whether as good a showing would have been made on continuous scant feeding of a wide ration. When all is said, however, the balance of profit still remains upon the side of the richer ration.

3. The cottonseed-linseed ration, fed 118 days, cost 7 per cent more than the Quaker oat feed ration fed the same length of time. It made 5 per cent more milk and 6 per cent more butter. The costs of making a pound of milk and a pound of butter were essentially identical. The cottonseed-linseed ration was the more costly, but really the cheaper of the two, since its use was followed by the production of $1.80 worth more of butter, about 100 pounds more of skim milk and additional fertilizing ingredients "valu-

ing" at $3.71. Using the assumption already mentioned under the first heading, the total gain amounts to $4.47, which, less $1.35, leaves net gain $3.12, daily net gain 2.64 cents.

4. The ration consisting of equal parts of corn and bran, fed 118 days, cost 2 per cent less than the Quaker oat ration, fed for the same length of time. Each ration made equal amounts of milk and of butter and at essentially equal cost. The corn and bran—equal parts—ration being slightly the cheaper of the two and containing more plant food, the balance is in its favor. To the "value" of two-thirds of the additional fertilizing ingredients, $0.44, should be added difference in cost in its favor, $0.31, making net gain $0.75, daily net gain 0.64 cents.

5. The cottonseed-linseed ration, fed 128 days, cost 3 per cent more than the buckwheat middlings ration, fed the same length of time. Each made the same amounts of milk and butter, with cost of manufacture slightly in favor of the buckwheat ration. From the "value" of two-thirds of the extra amount of fertilizing ingredients contained in the cottonseed-linseed ration, $0.70, should be deducted its extra cost, $0.52, and lessened butter value, $0.20, leaving net loss $0.02. The result is a balance between the two rations.

6. The ration consisting of equal parts of corn and bran, fed 72 days, cost 2 per cent less than the buckwheat middlings ration, fed for the same length of time. It made 2 per cent less milk and 4 per cent less butter, the cost of manufacture being essentially the same in each case. The former cost less than the latter, yet the more costly ration was the cheaper since the extra outlay for food was followed by the production of $0.80 worth more butter and of additional fertilizing ingredients "valuing" at $0.78. Using the assumption as before the total gain amounts to $1.32, which, less $0.18, leaves net gain $1.14, daily net gain 1.58 cents.

The salient points of the last table and the discussion following are shown below. The table gives the net gain from butter sales, net gain from butter, skim milk and manure, and net gains from feeding of one animal for one day when the ration first mentioned replaced that next referred to.

RELATIVE VALUE OF FEEDING RATIONS

CHARACTER OF RATIONS	Days fed to one cow	Net gain from butter sales at 20 cents	Net gain from butter, skim milk and manure	Net gain in cents from butter, skim milk and manure, one days' feeding of one cow
Buffalo gluten superior to cottonseed-linseed	529	$4.61	$6.05	1.14
Buffalo gluten superior to corn (2), bran (1)	276	—4.18	3.86	1.40
Cottonseed-linseed superior to Quaker oat feed	118	0.45	3.12	2.64
Corn and bran superior to Quaker oat feed	118	0.00	0.75	0.64
Cottonseed-linseed superior to buckwheat middlings	128	—0.72	—0.02	0.00
Buckwheat middlings superior to corn and bran	72	0.92	1.14	1.58

The Buffalo gluten feed viewed from the standpoint of dollars and cents easily outranks the others. The costs of the mixed and unmixed feeds were as follows:

Nos. 1 and 2	(cottonseed-linseed, etc., mixtures)	$19.34, $19.68 a ton
" 3	(buckwheat middlings, etc., ")	$16.75 a ton
" 4 and 5	(corn and bran)	$16.00, 16.33 a ton
Buffalo gluten feed, Quaker oat feed, respectively		$19.00, 16.50 a ton

The various rations differ in the contents and in the values of their fertilizing ingredients. Taking the cottonseed-linseed ration as the basis of comparison their relative fertilizing values were as follows: Cottonseed, etc., 100; Buffalo gluten feed, 100; buckwheat middlings, etc., 91; corn and bran (equal parts) 76; Quaker oat feed, 70; corn, 2 parts, bran, 1 part, 67.

XII. SUMMARY

The details given in the foregoing 41 pages may be summarized under their respective reference numbers and headings as follows:

1. *The nature of the problems studied.*—Fifty-six cows were used in the feeding trials. The tests lasted 32 weeks and were meant to determine so far as possible:

(*a*) The variation in production following the use of dissimilar rations affording food supplies equal in total amount and in the amounts of the different nutrients;—equal balance,—pages 262-269.

(*b*) The effect upon production of the addition to the ration of liquid fat, emulsified or unemulsified;—oil feeding,—pages 269-275.

(*c*) The variation in production following the use of two rations affording food supplies equal in total amount but unequal in the amounts of the different nutrients;—medium and wide rations,—pages 276-277.

(*d*) The variation in production following the use of two rations affording unequal food supplies, one being particularly deficient in protein;—medium and wide-scant rations,—pages 277-279.

(*e*) The feeding values of buckwheat middlings compared with half and half cottonseed and linseed meals; also compared with corn and bran, —pages 279-282.

(*f*) The feeding value of the improved french white artichoke compared with silage,—pages 282-283.

(*g*) The effect upon production of drinking at will as compared with watering at stated intervals,—pages 283-285.

(*h*) The effect upon production of grooming cows,—pages 285-286.

(*i*) The extent of experimental error in feeding tests,—pages 286-287.

2. *Methods, details, etc.*—The feeding periods were either 4 or 5 weeks long and 18 different rations were used. Full records were made, including weights of cows, fodders, milk, etc., barn temperatures were taken, and

constant analytical check was kept upon every phase of the work,—pages 254-261—also appendix to report.

3. *The relative feeding values of rations of equal balance.*

(*a*) *Medium nutritive ratios.*—The fodders and feeds used were hay, silage and Buffalo gluten feed—nutritive ratio averaging 1:5.7 and the same roughages with mixed feed No. 1—nutritive ratio averaging 1:5.6. The former ration yielded to the unit of total dry matter eaten from 4 to 5 per cent greater product, and the quality of the milk remained unchanged.

(*b*) *Wide nutritive ratios.*—The fodders and feeds used were hay, silage and corn and bran—and the same roughages with Quaker oat feed[1]—nutritive ratio in each case averaging 1:8.9. The former ration yielded to the unit of total dry matter eaten from 2 to 3 per cent greater product, the quality of the milk remaining uniform.

In the one case production to the unit slightly favored the ration which was fed the more liberally; in the other case two rations equally balanced and containing the same amounts of the sundry nutrients were of equal feeding value. The outcome of three years' trials of this kind indicates that uniform production is not to be expected of necessity when there are eaten equal amounts of digestible nutrients derived from divers sources,—pages 262-269.

4. *The effect of adding raw or emulsified fat to a ration.*—Unemulsified cottonseed oil and emulsified cottonseed, corn and linseed oils were fed with bran or corn meal and bran, hay and silage, as against the same rations without the oil. Milk yields to the unit of dry matter eaten were always increased when oil was fed, the increase amounting from 3 to 9 per cent. The amount of total solids and fat were increased by the cottonseed oil feeding from 2 to 15 per cent, on linseed oil feeding 2 per cent and on corn oil feeding not at all. The quality of milk was always improved at the outset of this class of feeding but quickly returned to normal quality or became poorer than usual when corn or linseed oils were fed. The increased fat percentage —unaccompanied by rise in the percentage of solids-not-fat—was fairly permanent, lasting from 4 to 6 weeks at least, when either raw or emulsified cottonseed oil was used. Since the same changes were brought about when raw oil was fed as followed the use of emulsified oil, it is safe to say that in these trials emulsifying was without influence as a means of feeding fat into milk,—pages 269-275.

5. *The feeding values of medium and wide rations.*

(*a*) *Grain rations equal in amount.*—The fodders and feeds used were hay, silage and mixed feed No. 1, or the same roughages and Quaker oat

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1 The manufacturers of this product, now sold under the name of Quaker Dairy Feed, have raised its grade in protein. Samples found on the Vermont market in the winter of 1899-1900 contained notably more of this ingredient than the goods used in the feeding trials here summarized.

feed.[1] Nutritive ratios averaged 1:5.8 and 1:9.0. The producing power of a unit of dry matter was 7 per cent greater in the former ration. The fat content of the quality of the milk remained essentially unchanged.

(*b*) *Grain rations unequal in amount.*—The fodders and feeds used were hay, silage and 8 pounds of Buffalo gluten feed or the same roughages with 2 pounds of corn meal and 1 pound of bran. Nutritive ratios averaged 1:5.5 and 1:9.7. The unit of dry matter eaten in the medium ration made 5 per cent more milk than did that in the wide ration. Less but richer milk seemed to be produced by the scant ration,—pages 276-279.

6. *The feeding value of buckwheat middlings.*—The fodders and feeds used were hay, silage, corn meal, bran and buckwheat middlings, the same roughages with mixed feed No. 1 or corn meal and bran. A unit of dry matter eaten produced about 3 per cent more milk, solids and fat in ration No. 1, and about 4 per cent less in the corn and bran ration than when the middlings were fed. The quality of the milks remained generally uniform, with, however, two exceptions,—pages 279-282.

7. *The feeding value of artichokes.*—Hay, silage and mixed feed No. 1 or hay, artichoke tubers and mixed feed No. 1 were fed to one cow. To the unit of dry matter eaten 10 per cent less milk was made on the silage ration, —pages 282-283.

8. *Watering at will or at intervals.*—Cows fed a uniform ration were in alternating periods watered at will or at intervals, and in the former case made 2 per cent more milk. The effect upon quality cannot be stated for reasons given in the body of the article,—pages 283-285.

9. *The grooming of cows.*—Cows fed a uniform ration were in alternating periods groomed or left uncarded without appreciable effect either upon milk yield or quality,—pages 285-286.

10. *Experimental error.*—Uniform rations were fed and uniform production ensued. A unit of dry matter made essentially the same milk, solids and fat at one time as another, lactation changes being equalized. It is probably unsafe to lay stress on apparent differences in feeding values of much less than 5 per cent,—pages 286-287.

11. *Relative values of various grain rations.*—Assuming that two-thirds of the manurial ingredients reach the soil, and allowing 20 cents per hundred for skim-milk, the total and the daily net gains of one ration over another in butter, skim-milk and manure, expressed in dollars and cents are as shown in the table. In each case the ration first mentioned proved superior to its competitor.

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1 See footnote opposite page.

RELATIVE VALUE OF FEEDING RATIONS

RATIONS	Days fed to one cow	Net gain from butter sales at 20 cents	Net gain from butter, skim milk and manure	Net gain from butter, skim milk and manure, one days' feeding of one cow
Buffalo gluten superior to cottenseed-linseed	529	$4.61	$6.09	$3.35
Buffalo gluten superior to corn (2), bran (1)	276	—4.18	3.86	3.40
Cottonseed-linseed superior to Quaker oat feed	118	0.45	3.12	2 64
Corn and bran superior to Quaker oat feed	118	0.	0.75	0.69
Cottonseed-linseed superior to buckwheat middlings	128	—0.72	—0.02	0.
Buckwheat middlings superior to corn and bran	72	0.92	1.14	1.58

The Buffalo ration proved superior to the others, the cottonseed-linseed ration ranking second. Pages 288–293.

THE EFFECT OF FOOD UPON THE QUALITY OF BUTTER

The effect of various concentrates upon the quality of butter has been studied during the past year in continuation of the work published in the last two reports. Many samples of the skimmilk, buttermilk and butter made on the various rations were analyzed and the latter was critically examined as to its quality. These tests were made in connection with the feeding trials reported under the last heading. The experimental scheme was such that there was no continuity of the animals upon a single ration. They were shifting about to such an extent that the effect of individuality upon the character of the butter must have been lost.

The rations used are described on page 260 in connection with the previous article. The rations fed contained hay, and, usually, silage as roughage and the following concentrates; cottonseed, linseed and corn meals and bran, in two different combinations; corn meal and bran in two different combinations; corn meal, bran and buckwheat middlings; Buffalo gluten feed; Quaker oat feed, Emulsified cottonseed, corn and linseed oils were at times added to the corn and bran ration.

The milks were separately creamed and churned from March 8 to May 1. Forty-four separate butter samples and as many each of skimmilk and buttermilk were drawn during this time and analyzed. The butter from each churning was critically examined by the station dairyman.

GRAIN TESTS

The following statement shows the results of analyses on butters made on sundry rations.

Character of feed	Number of samples	Volatile acids	Iodin number	Melting point
Cottonseed, linseed, corn and bran	4	29.1	27.6	33.7 °C
Buckwheat middlings, corn and bran	1	30.2	26.9	34.5 °C
Corn and bran	5	29.8	28.7	33.5 °C
Buffalo gluten feed	4	27.3	28.0	33.7 °C
Quaker oat feed	3	30.0	28.6	33.3 °C

These figures show uniformity, with the exception of the single buckwheat sample. This one was exceeded by but 2 in 16 samples in volatile acids, was lower than 14 in 16 in iodin number and had the highest melting point of all the samples. This may mean relatively more stearin and a firmer butter from buckwheat middlings feeding.

All of these butters were rated good by the station dairyman. Apparently none of these feeds injuriously affected the quality of the butter. Bartlett[1] has pointed out that the well-known softening effects of gluten feeding is due in large measure to the high fat content common to this class of goods and that gluten by-products with 3 per cent or less of fat do not soften butter. The Buffalo brand used in the tests now under discussion was of the latter type.

OIL TESTS

The analyses of the butter-fat made by the oil-fed cows are an interesting lot. The first two samples represent the product made when oil had been fed for four weeks, the last two that made during the week immediately following the withdrawal of the oil from the ration.

	Corn oil			Cottonseed oil			Linseed oil		
	Vol. acid	Iodin No.	Melting point	Vol. acid	Iodin No.	Melting point	Vol. acid.	Iodin No.	Melting point
Oil fed	17.6	44.1	34.3 °C	23.6	39.3	36 8 °C	20 4	48.7	34.4 °C
Oil fed	18 0	45.2	34.3 °C	22.7	40.2	36.0 °C	20.0	46 8	33.8 °C
No oil fed	19.8	40.3	34.3 °C	24.1	36.4	36.0 °C	20.9	42.7	33.0 °C
No oil fed	22.9	33.0	34.7 °C	26.3	32.5	34.3 °C	24.0	34.6	34.1 °C
Average of other cows as shown in upper table	29.3	28.0	33.8 °C	29.3	28.0	33.8 °C	29.3	28.0	33 8 °C

Volatile acids were uniformly and decidedly lowered, and the iodin numbers markedly increased in every case when oil was fed and for a while after its use was abandoned. This was more apparent when corn and linseed oils were fed than when the cottonseed oil was used. The melting point of the product made when the latter oil was fed was raised. The results with the cottonseed oil feeding are parallel to those obtained last year.

The residual effect of former feeding is shown by the slow rate of the return towards ordinary quality. The figures after the oil feeding ceased tend back towards the normal but even the butter made from four to eight days after oil feeding had ceased had not become of the usual type.

The station dairyman's judgment of these butters was that the cottonseed product was hard and of quite good flavor, that made on linseed oil

1 Me. Sta. Rpt. 14, pp. 97-113 (1898).

was very soft and sticky, and of an oily taste—a condition lasting until the second sample after the use of oil was discontinued,—while that made on corn oil was somewhat soft and oily but fair in quality.

The iodin number is relatively high when the softer fats—olein and linolein—are in excess and low when the harder fat—stearin—is in larger proportion. The linseed and corn oils are relatively rich in the fluid oils and cottonseed oil in the harder fat. While it is unsafe with our present lack of knowledge concerning the methods of milk formation to assert actual transfer from food to milk, yet analytical results and practical experience are in accord with such a theory. This view is taken by Baumert and Falke[1], who, having fed emulsified sesame, cocoanut and almond oils state that "butter fat was produced which corresponded in its chemical properties to artificial mixtures of butter with these three oils." They deem the practice "an adulteration of butter in the animal's body." The general results of these investigations as well as those of Morse[2] and of Bartlett (*loc. cit.*) are in accord with the outcome in the present series of tests. They serve to show that, be the transfer direct or indirect, it is possible by certain abnormal methods of feeding,—such as feeding fluid fat, emulsified or raw to cows,—to produce an abnormal butter usually of an inferior character.

EFFECT ON CREAMING, CHURNING, ETC.

Careful record of the quality of separator skimmilks, buttermilks, times of churning, etc., was kept throughout these tests. Study of the data shows so many inequalities that deductions are thought unsafe. One set of results, however, is consistent. The milk made on cottonseed oil feeding invariably skimmed and churned more exhaustively than that made on either linseed or corn oil feeding. Differences were quite pronounced, as is shown below:

	Skimmilk			Buttermilk		
	Minimum	Maximum	Average	Minimum	Maximum	Average
Cottonseed oil	0.03	0.06	0.05	0.14	0.17	0.15
Corn oil	0.09	0.16	0.13	0.30	0.98	0.55
Linseed oil	0.19	0.25	0.22	0.25	0.80	0.40

It will be noted that the maximums on the cottonseed are smaller than the minimums on either of the other oils. This may be a coincidence yet it suggests the thought that possibly the greater proportion of the softer oils in the fats of the milks produced on the feeding of the latter two oils tended to promote loss.

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1 Zeit. Untersuch Nahr. u. Genussmtl. 10, pp. 665-678 (1898).

2 N. H. Sta. Bul. 16, (1892).

RECORD OF THE STATION HERD FOR 1897-98

A record has been kept of the dairy performances of each cow in the station herd from its establishment in 1889. For some years these records have been tabulated and commented upon in the station publications.[1] This work will be continued and it is hoped that in the future the vast amount of data thus collected may be digested and matter of value obtained. The records for 1892 and 1893 cover production only. Those for the past four years have also shown important data connected with the economy of production. The records shown on the next three pages, therefore, include for each cow not only the production of milk, total solids, fat and butter, but also the cost of the food eaten to the 100 pounds of milk and to the pound of fat and butter, the cost of the total food eaten, of the purchased grain, the net proceeds from butter sales—at the average price actually received during the year for butter—and the value of the fertilizing ingredients in the fodders and feed eaten.

The average production of milk and of butter for the entire herd in the successive years has been satisfactory and quite uniform. The butter productions have been as follows: 1892, 335 pounds; 1893, 330 pounds; 1894, no record; 1895, 325 pounds; 1896, 324 pounds; 1897, 338 pounds; 1898, 313 pounds. The herd of 1892–93 contained about twenty cows and was slaughtered early in 1894 because of tuberculosis. The animals included in the present herd were bought at various times, but mostly in April and October, 1894, January, 1895, and September, 1897. There were 54 cows in the herd within the limits of the record year—November 1, 1897–October 31, 1898—but only 42 were members throughout the year. Of the remaining 11 four were bought in September, 1898, three were two-year-olds which first calved in the summer of 1898, three were killed during the year for beef and one died of milk fever. The records of these 11 cows have been kept as carefully as have those of the animals which completed the year. These broken records have not the value that belongs to complete data, yet, inasmuch as four of these cows have figured in past records and six of them will figure in future ones, it is thought best to publish the figures. They follow the main tabulation on page 302. The 42 cows at the farm throughout the record year include six two-year-olds, one of which did very poorly, and seriously lowered the average. The 36 older cows averaged 325 pounds of butter. The animals whose names are italized in the tables are registered Ayrshires (or capable of registration) those in black face, registered Jerseys. All others are high grade Jerseys. Many of the animals have higher records in past years than those given in the present tabulation.

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1 Vt. Sta. Bul. 33 (1893); do. Rpts. 6, pp. 119-121 (1892); 7, pp. 82-83, (1893); 9, pp. 187-192, (1895); 10, pp. 181-188 (1897); 11, pp. 355-365 (1898).

RECORD OF THE HERD OF THE VERMONT AGRICULTURAL EXPERIMENT STATION FOR THE YEAR FROM NOV. 1, 1897 TO OCT. 31, 1898

Cow	Approximate weight	Age November 1, 1897	Calved in 1897	Calved in 1898	Days in milk.	Milk	Total solids	Fat	Total solids	Fat	Butter
						lbs	%	%	lbs	lbs	lbs
Acme 5th, 10342 A. R.	900	8	Jan. 18, '98	Dec. 25	283	6770	11.83	3.72	800.9	251.9	293.9
Annie	780	2	June 15	Nov. 9	290	2344	14.08	4.74	330.1	111.2	129.8
Atalanta, 10777 A. R.	950	8	Dec. 1	Nov. 16	275	6206	12.38	3.75	768.6	233.0	271.9
Bess	870	11	March 7	Farrow	365	5262	14.92	5.69	785.3	299.4	349.4
Bettie	970	9	*Mar. 15	Feb. 6	261	6820	13.11	4.36	894.0	297.6	347.3
Brownie	910	8	July 18	*Sept. 10	339	4863	14.51	5.16	705.5	250.8	292.7
Carmen	960	8	Aug.	Farrow	365	4808	13.87	4.76	667.1	229.1	267.3
Ceres	800	7	July	*Sept. 18	365	6389	15.16	5.86	968.7	374.5	437.1
Clare	930	10	July	Jan 23, '99	365	5259	14 83	5.25	780.1	276.0	322.1
Clover	1000	10	*July 25	Mar. 11, '99	358	3560	16.01	6.33	569.8	225.2	262.8
Dandelion	920	8	March 18	Feb. 28	328	5776	14.56	5.46	841.1	315.5	368.2
Dora	850	8	Sept. 25	Farrow	365	4704	14.96	5.60	703.3	263.4	307.4
Eulalie	1140	8	June 8	Nov. 12	271	3334	14.38	5.22	479.4	174.1	203.2
Fairie	800	8	March 6	March 9	325	6207	14.09	5.01	874.6	311.0	362.9
Flora	930	8	Sept. 27	Feb. 7. '99	354	8045	13.79	4.80	1109.5	385.8	450.3
Flox	970	7	Nov. 27	Farrow	335	6427	12.89	4.13	828.5	265.5	309.8
Golden Rod	1030	6	Apr. 5	May 11	292	5372	15.40	5.96	827.2	320.1	373.6
Goldie	1000	11	Farrow	Aug. 10	350	5416	15.33	5.53	830.2	299.3	349.3
Idarella	940	7	March 27	Feb. 16	327	6410	14.28	5.05	915.1	323.8	377.9
Jeannie	880	8	May 9	March 16	338	5372	13.69	4.79	735.5	257.4	300.4
Jersey Lily	960	6	March 6	May 10	314	5630	14.56	5.36	819.6	301.9	352.4
Lady Perusia 123228 A. J. C. C.	850	4	Sept. 10	*Oct. 10	309	2990	15.68	6.01	468.8	179.6	209.6
Lala	790	5	June	Nov. 12	291	3950	14.60	5.20	576.8	205.5	239.8
Maizie	960	11	*July 30	Nov. 23	260	2887	14.46	5.01	417.4	144.7	168.8
Marjory	870	9	Sept. 22	Farrow	365	7697	13.97	5.05	1075.2	388.8	453.8
Max Belle 108996 A. J. C. C.	890	5	*Sept. 30	*Aug. 7	354	3213	15.57	6.14	500.4	197.3	230.2
Max Ella	880	6	August	Nov. 22	354	5521	13.84	4.79	764.0	264.4	308.6
Minta Bella 85578 A. J. C. C.	700	6	Farrow	Jan. 10	325	6036	14.62	5.54	882.1	334.2	390.0
Nancy B 9581 A. R.	1040	10	March 30	Nov 6	268	7662	12.57	3.80	963.2	291.0	339.7
Naomi	640	2	Dec. 1	Feb. 1, '99	333	5359	13.93	4.58	746.6	245.7	286.7
Pauline	700	2	Nov. 20	Dec. 16	342	5515	14.09	4 80	777.0	264.8	309.0
Polela	770	3	Aug. 20	Jan. 10, '99	361	4769	15.28	5.81	728.9	277.1	323.1
Polly		9	Sept. 18	Feb. 8, '99	365	6475	14.81	5.53	944.1	352.6	411.5
Pomona	790	6	July	Jan. 30, '99	365	6898	14.94	5.54	1030.6	382.4	446.3
Priscilla	810	2	Sept. 25	Nov. 25	353	3947	15.49	5.90	611.5	232.7	271.6
Pussy Willow	760	6	Sept. 6	Jan. 22, '99	365	4835	15.18	5.74	733.9	277.7	324.1
Rachel	810	6	July	Oct. 5	305	4861	15.59	5.86	757.9	285.0	332.6
Red Top	900	8	Oct. 18, '96	Feb. 7	308	6344	12.51	3.97	793.7	252.1	294.2
Rose	660	2	Sept.	Oct. 26	300	3635	15.78	5.76	478.9	174.7	203.8
Rowena	910	6	March 25	March 27	328	6747	13.55	4.46	914.0	301.0	351.3
Ruth	680	2	May 30	Aug. 10	334	4220	14.49	4.88	611.5	205.8	240.2
Salida	910	4	Nov. 24	Feb. 21, '99	339	4622	14.41	5.10	666.1	235.8	275.2
Average of 42 cows					328	5296	14.24	5.06	754.4	268.1	312.9
Average of 36 cows (2-yr-olds omitted)					328	5500	14.20	5 06	781.1	278.5	325.0

HERD RECORD—Continued

Cow	Total cost of food	Total cost of purchased grain	Cost of food for 100 pounds of milk	Cost of food for 1 pound of fat	Cost of food for 1 pound of butter	Proceeds from butter sales at 25¾ cents per pound	Value of fertilizing ingredients in food fed in barn
	$	$	cts	cts	cts	$	$
Acme 5th, 10342 A. R.	46.27	12.90	68.3	18.4	15.7	75.68	23.53
Annie	36.62	11.18	156.2	32.9	28.2	33.42	18.05
Atalanta 10777 A. R.	40.85	13.07	65.8	17.5	15.0	70.00	20.49
Bess	50.82	22.35	96.6	17.0	14.5	89.97	24.28
Bettie	44.36	11.79	65 1	14.9	12.8	89.42	21.33
Brownie	47.48	16.79	97.6	18.9	16.2	75.36	23.61
Carmen	54.21	20.71	112.8	23.7	20.3	68.82	27.43
Ceres	48.35	15.98	75.7	12.9	11.1	112.54	25.33
Clare	51.48	17.40	97.9	18.7	16.0	82.94	25.26
Clover	48.47	17.05	136.2	21.5	18.4	67.66	23 98
Dandelion	48.40	15.05	83.8	15.3	13.1	94.80	24.78
Dora	46.59	19.30	99.0	17.7	15.2	79.14	23.90
Eulalie	42.31	14.30	126.9	24.3	20.8	52.32	22.71
Fairie	45.03	15.10	72.6	14.5	12.4	93.44	22.37
Flora	49.73	17.73	61.8	12.9	11.0	115.95	26.11
Flox	49.60	17.37	77.2	18.7	16.0	79.80	24.02
Golden Rod	48.74	12.90	90.7	15.2	13.0	96.20	25.00
Goldie	51.30	20.54	94.7	17.1	14.7	89.94	26.14
Idarella	52.72	18.87	82.2	16.2	14.0	97.30	25.94
Jeannie	47.22	16.49	87.9	18.3	15.7	77.34	23.74
Jersey Lily	49.11	15.26	87.2	16.2	13.9	90.74	25.20
Lady Perusia 123228 A. J. C. C.	41.69	15.16	139.4	23.2	19.9	53.97	22 25
Lala	40.02	13.99	101.3	19.6	16.7	61.74	19.91
Maizie	37.40	13.94	129.6	25.9	22.2	43.46	18.26
Marjory	50.30	18.03	65.4	13.0	11.1	116.84	26.87
Max Belle, 108896 A. J. C. C.	44.38	14.76	138.2	22.5	19.3	59.27	21.95
Max Ella	49.06	16.76	88 9	18.6	15.9	79.46	24.35
Minta Bella, 85578 A. J. C. C.	46.33	13.83	76.8	13.9	11.9	100.41	24.19
Nancy B., 9581 A. R.	45.67	14.48	59.6	15.7	13 4	87.46	24.03
Naomi	42.76	14.64	79.8	17.4	14.9	73.82	20.21
Pauline	41.82	14.76	75.8	15.8	13.5	79.56	20.49
Polela	49.62	17.64	104.0	17.9	15.4	83.19	26.28
Polly	50.61	16.28	79.4	17.8	12.3	105 96	26.62
Pomona	49.63	17.23	71.9	13.0	11.1	114.91	16.08
Priscilla	46.80	16.88	118.6	20.1	17.2	69.93	23.79
Pussy Willow	49.99	16.58	103.4	18.0	15.4	83.44	26.09
Rachel	42.34	14.75	87.1	14 9	12.7	85.64	21.20
Red Top	49.85	13.79	78.6	19.8	16.9	75.75	25.56
Rose	35.09	10.91	115.6	20.1	17.2	52.48	18.07
Rowena	44 46	11.35	65.9	14.8	12.7	90.46	22.05
Ruth	45.56	17.25	108.0	22.1	19.0	61.84	22.59
Salida	46.05	15.50	99.6	19.5	16.7	70.86	22.66
Average of 42 cows	46.40	15.73	93.4	18.2	15.6	80.55	23.25
Average of 36 cows (2-yr-olds omitted)	47.23	15.98	90.8	17.7	15.1	83.66	23.71

RECORD OF THE HERD OF THE VERMONT AGRICULTURAL EXPERIMENT STATION FOR THE YEAR FROM NOV. 1, 1897 TO OCT. 31, 1898.—Continued.

Cow	Approximate weight	Age November 1, 1897	Calved, 1897	Calved, 1898	Days in milk	Milk	Total solids	Fat	Total solids	Fat	Butter
						lbs	%	%	lbs	lbs	lbs
Cressy of Brondale 75974, A. J. C. C.	960	9	Farrow	Died	199	2398	15.47	5.78	370.9	138.6	161.7
Edna				Midsum'r	81	2040	13.51	4.66	275.5	95.0	110.9
Eva				Midsum'r	81	1794	14.15	5.30	253.9	95.0	110.9
Foolie		1½		June 19	135	1380	13.36	4.38	184.4	60.4	70.5
Haidee		1½		Aug. 16	60	1187	13.71	4.52	162.7	53.7	62.7
Inez				Midsum'r	81	1542	14.38	5.19	221.8	80.0	93.4
Jessie	900	8	Dec. 1	Killed	82	1916	13.99	5.12	267.9	98.1	114.5
Kittie	850	8	Farrow	Killed	30	110	15.91	6 18	17.5	6.8	7.9
Orpha				Midsum'r	81	1884	12.85	3.82	242.1	71.9	83.9
Regina	910	8	Farrow	Jan. 8	178	1372	12.62	3.87	173.2	53.1	62.0
Sue		1½		June 24	128	2786	11.56	3.64	322.1	101.5	118.4
Average					103	1692	13.77	4.77	226.5	77.6	93.4

HERD RECORD—Continued.

Cow	Total cost of food	Total cost of purchased grain	Cost of food for 100 pounds of milk	Cost of food for 1 pound of fat	Cost of food for 1 pound of butter	Proceeds from butter sales at 25¾ cents per pound	Value of fertilising ingredients in food fed in barn.
	$	$	cts	cts	cts	$	$
Cressy of Brondale, 75974 A. J. C. C.	27.07	12.56	112.9	19.5	16.7	41.63	16.32
Edna	8.91	3.33	43.7	9.5	8.0	28.55	4.68
Eva	9.05	3.38	50.5	9.6	8.2	28.55	4.55
Foolie	19.86	6.41	143.9	32.9	28.2	18.15	7.99
Haidee	12.91	3.09	108.8	24.0	20.6	16.14	7.54
Ines	8.81	3.28	57.1	11.0	9.4	24.05	4.65
Jessie	14.13	4.41	73.7	14 4	12.3	29.48	8.00
Kittie	4.23	0.42	384.5	62.2	53.5	2.04	2.41
Orpha	9.05	3.34	48.0	12.6	10.8	21.60	4.86
Regina	27.45	14.70	200.1	51.7	44.3	15.96	16.68
Sue	18.36	3.69	65.9	18.1	15.5	30.48	7.24
Average	14.53	5.33	117.2	24.1	20.7	23.33	7.72

The following remarks are explanatory of the record tables.

"*Pounds of milk*" are obtained by weighing each milking of each cow throughout the year.

"*Per cent of fat*" is obtained through averaging by cross-division. Composite samples—eight milkings each—are taken of the milk of each cow bi-monthly throughout the year and constantly while on feeding experiment.

"*Pounds of butter*" are obtained by adding *one-sixth* to the pound of fat, this being the factor adopted by the Association of american agricultural colleges and experiment stations and based upon the world's fair dairy tests. This is equivalent to a "surplus" of 16.7 per cent. The conditions of our work (frequently sampling, varying methods of manufacture, frequent handling of relatively small quantities, etc.,) are such that it is doubtful whether our average "surplus" is as high as 16.7 per cent. Much of our product is sold as cream, some as milk, and large amounts are taken as samples, hence our exact make *all as butter* cannot be stated. Conservative estimates of the butter values of these last three items together with butter sales made in past years have shown a surplus of 12 to 14 per cent. It would be unfair, however, to charge against the cows the relatively small losess of butter which are to a considerable extent caused by the peculiar nature of our work and which would not pertain to ordinary dairy management.

"*Cost of food*" is reckoned from prices paid for grain—corn meal $15.75, bran, $15, cottonseed meal, $23.50, linseed meal, $25, Atlas gluten meal, $16—hay, $10, silage, soiling crops, etc., $3.00; pasturage for the season, $5 per animal.

The average cost of food for 100 pounds of milk and for a pound of butter is obtained by dividing the total by 42, the number of cows. Each animal is given thus the same value in the average, be she good, bad or indifferent. *As a herd* the average cost of food for 100 pounds of *herd* milk was 87.6 cents while that for a pound of butter was 14.8 cents (46.40 ÷ 5296 × 100 and 46.40 ÷ 313 × 100).

The figures showing "cost of 100 pounds of milk" and "cost of one pound of butter," include only the cost of food as laid down in barn ready for feeding. They do not include cost of feeding, caring for cows, making and marketing butter, depreciation of plant, interest on investment, etc.

It should be noted, however:

1. That "roughages" are rated at figures more than high enough to cover cost of raising and harvesting in average seasons.

2. That the fertilizing ingredients in the food fed at the barn are worth half of the rated cost of the food, reckoned at market prices for the same plant food of similar availability in the form of commercial fertilizers. There are also considerable amounts of plant food in the pasture grass not included in the schedule.

3. That the fertilizing ingredients in the grain purchased are worth 59 per cent of its market price.

4. That 7 tons of butter remove but $2.90 worth of plant food from the farm.

5. That the increase of the herd and the sales of calves and fat cows are further items not considered above.

6. That the skimmilk and buttermilk from the 42 cows, at 20 cents per hundred—which was its feeding value found in the pig feeding experiments of 1895 and 1896, the last made at this station—with dressed pork at 5 cents were worth $418.60 as food.

Twenty-five of the 42 cows whose records appear in the preceding table figured likewise in the records of 1895–96 and of 1896–97, and 20 in that of 1894–95. It is of interest to compare the record of these four years for each cow.

	No. of cows	Pounds of milk	Per cent of fat	Pounds of butter	Total cost of food	Total cost of purchased grain	Cost of food for one pound of butter	Proceeds from butter sales*
Average record for the year 1894–95	31	5633	4.95	325	$50.06	$ 18.85	16.2 cts.	$76.40
" " " " 1895–96	37	5431	5.12	324	42.00	14.22	13.8 cts.	74.51
" " " " 1896–97	29	5730	5.06	338	47.45	18 69	15.3 cts.	82.04
" " " " 1897–98	42	5296	5.06	313	46.40	15.73	15.6 cts.	80.58
Average record of the same 19 cows for each year :								
1894–95	....	5864	4.94	338	53.16	19.92	17.6 cts.	79.30
1895–96	....	5927	5.01	347	43.54	14.75	13.5 cts.	79.77
1896–97	....	6475	4.87	368	49.77	19.26	14.0 cts.	89.24
1897–98	....	5631	4.95	318	46.54	15.48	15.1 cts.	81.85
Average record of the same 24 cows for three years :								
1895–96	....	5657	5.12	338	42.56	14.45	13.3 cts.	77.76
1896–97	....	6012	5.04	354	48.66	18.98	13.8 cts.	85.80
1897–98	....	5698	5.00	325	46.98	15.71	15.0 cts.	83.69

The herd, as a whole, made the most milk and butter to the cow during 1896–97. The butter was made more cheaply during 1895–96. Yet, owing to better selling prices the financial showing is best during 1896-97. The excess of proceeds per cow over total cost of food for the 4 years respectively, is $26.34, $32.51, $34.59 and $34.15. The more favorable results of the last two years, are entirely due to better selling prices. Had the average receipts for a pound of butter in these last two record years—24¼ cents—been the same as the one immediately preceding,—23 cents—the average proceeds for butter sales would have been $77.74, and the excess over cost of food $30.29.

The following table shows extremes of quantity, quality, cost of production, etc., during 1897-98.

*Average receipts for butter, 1894–95, 23½ cts.; 1895–96, 23 cts.; 1896–97, 24¼ cts.; 1897–98, 25¾ cts.

AVERAGE DAIRY HERD RECORD FOR FOUR YEARS, 1895–1898.

NAME	Years of record	Pounds of milk	Per cen tofat	Pounds of butter	Total cost of food	Cost of purchased grain	Cost of food for one pound of butter in cents	Proceeds from butter sales, (23-25¼c ℔ lb)	Pounds of butter each year			
									1895	1896	1897	1898
Acme 5th, 10342 A. R.	4	7658	3.93	351	$49.65	$16.73	14.3	$84.20	383	386	340	294
Annie (2-year-old)	1	2344	4.74	130	36.62	11.18	28.2	33.42	----	----	----	130
Atalanta 10777 A. R.	4	6828	3.77	300	46.87	16.70	15 7	72.15	298	315	314	272
Bess	4	6445	5.47	411	52.42	19.98	12.9	98.73	462	406	425	349
Bettie	4	5654	4.81	317	46.32	15.61	15.2	76.43	*281	*396	*245	347
Brownie	4	5811	5.31	360	47.32	15.92	13.6	86.28	331	459	357	293
Carmen	1	4808	4.76	267	54.21	20.71	20.3	68.82	----	----	----	267
Ceres	1	6389	5.86	437	48.35	15.98	11.1	112.54	----	----	----	437
Clare	1	5259	5.25	322	51.48	17.40	16.0	82 94	----	----	----	322
Clover	4	4310	6.21	312	49.13	17.88	16.4	74.80	258	423	304	*263
Dandelion	4	5534	5.56	359	45.79	16.63	12.9	86.69	301	365	402	368
Dora	4	4783	5.63	314	44.87	17.96	14.3	75.79	369	*255	325	307
Eulalie	4	5494	4.93	316	47.52	15.70	15.8	75.48	371	396	294	203
Fairie	4	6058	5.29	374	45.38	17.18	12.3	90.13	338	337	459	363
Flora	4	5679	5.03	333	44.94	16 93	14.4	81.32	264	219	399	450
Flox	3	5277	4.65	286	45.44	17.59	16.5	69 49	----	*346	*202	310
Golden Rod	4	5496	6.29	403	49.69	17.55	12.4	96.97	415	391	430	374
Goldie	4	5366	5.50	344	50.68	18.59	15.0	83.18	356	275	396	349
Idarella	3	6293	5.15	378	48.16	17.91	12.8	92.13	----	356	401	378
Jeannie	4	5579	4.92	320	46.36	17.70	15.7	76.94	188	*417	373	300
Jersey Lily	4	5688	5.56	369	47.00	16.38	12.8	88.92	342	370	411	352
Lady Perusia 123228 A. J. C. C.	1	2990	6.01	210	41.69	15.16	19.9	53 97	----	----	----	210
Lala	1	3950	5.20	240	40.02	13.99	16.7	61.74	----	----	----	240
Maizie	4	5051	4.80	283	45.39	17.14	17 5	68.03	355	194	415	*169
Marjory	3	5888	5.26	361	46.61	17.00	13.2	88.29	----	335	293	454
Max Belle 108997 A. J. C. C.	3	3385	6.36	251	40.68	14.94	16.3	61.05	----	†262	*262	*230
Max Ella	1	5521	4.79	309	49.06	16.76	15.9	79.46	----	----	----	390
Minta Bella 85578 A. J. C. C.	3	5504	6.16	395	42.10	14.23	10.6	96.22	----	†345	450	309
Nancy B. 9481 A. R.	4	7586	3.96	350	49.87	17.66	14.4	84.57	356	288	416	340
Naomi (2-year-old)	1	5359	4.58	287	42.76	14.64	14.9	73.82	----	----	----	287
Pauline (2-year-old)	1	5515	4.80	309	41.82	14.76	13.5	79.56	----	----	----	309
Polela	1	4769	5 81	323	49.62	17.64	15.4	83.19	----	----	----	323
Polly	1	6375	5.53	412	50.61	16.28	12.3	105.96	----	----	----	412
Pomona	1	6898	5.54	446	49 63	17.23	11.1	114.91	----	----	----	446
Priscilla (2-year-old)	1	3947	5.90	272	46.80	16.88	17.2	69.93	----	----	----	272
Pussy Willow	1	4835	5.74	324	49.99	16.58	15.4	83.44	----	----	----	324
Rachel	1	4861	5.86	333	42.34	14.75	12.7	85.64	----	----	----	333
Red Top	4	6741	4.44	349	52.11	16.84	15.5	84.05	284	358	460	294
Rose (2-year-old)	1	3035	5.76	204	35.09	10.91	17.2	52.48	----	----	----	204
Rowena	4	6174	4.54	327	49.13	16.29	15.9	78.91	211	384	360	351
Ruth (2-year-old)	1	4220	4.88	240	45.56	17.25	19.0	61.84	----	----	----	240
Salida (2-year-old in '97)	2	3097	5.18	187	41.98	16.18	27.5	47.47	----	----	99	275
Average of 42 cows		5297	5.16	319	46 45	16.46	15.5	71.95	324	345	353	313
Average of 36 cows (exclusive of 2-year-olds)		5501	5.19	333	47.23	16.83	15.0	73.64				

*Aborted. †For 9 months.

EXTREMES OF PRODUCTION

	Lowest amount for any cow		Highest amount for any cow		Ratio of lowest to highest
Pounds of milk	2344	Annie	8045	Flora	1 : 3.43
Per cent of total solids	11.83	Acme	16.01	Clover	1 : 1.36
Per cent of fat	3.72	"	6.33	"	1 : 1.70
Pounds of total solids	330.1	Annie	1109.5	Flora	1 : 3.36
Pounds of fat	111.2	"	388.2	Marjory	1 : 3.50
Pounds of butter	129.8	"	453.8	"	1 : 3.50
Cost of feed	$35.09	Rose	$84.21	Carmen	1 : 1.54
Cost of grain	$10.91	"	$22.35	Bess	1 : 2.05
Cost of 100 pounds of milk	59.6cts	Nancy B	156.2cts	Annie	1 : 2.62
Cost of 1 pound of fat	12.4 "	Flora	39.2 "	"	1 : 3.56
Cost of 1 pound of butter	11.0 "	"	28.2 "	"	1 : 3.56
Value of butter product at actual selling price	$33.42	Annie	$116.84	Marjory	1 : 3.50
Value of fertilizing ingredients in food	$16.68	Pomona	$27.43	Carmen	1 : 1.71

These extremes are wide. The butter made by the poorest cow cost for food alone more than was obtained for it, even at the relatively high price at which the station butter is sold. Yet the statistics published a few years ago by the State board of agriculture show that even in this dairy state of Vermont, the yearly average production of butter per cow is not much greater than that made by the cow Annie. Less grain is fed as a rule than was eaten by this cow but on the other hand the average price received per pound of butter is undoubtedly less.

The following table shows the feeding record of each of the 53 cows which were members of the herd within the record year. All of the cows were out to pasture for about five and one-half months, but were housed over night during this time. They were fed twice daily the year around, grained during the summer to some extent, watered (in winter) twice a day, and turned out in the winter for from 20 to 40 minutes daily except in extreme weather. The station herd is used in feeding experiments for six months, during which time the cows are subjected to many changes in ration. In some cases materials may be fed which are distasteful, and frequently wasteful or ill-balanced rations are used. These changes, necessitated by the conduct of feeding experiments, are obviously not conducive to the largest production. During the winter the nutritive ratios varied from 1:5.2 to 1:12.7. The average for the winter feeding would probably be not far from 1:7.5. At no time was special effort made to select or to feed the most economical ration, or to force any cow to a maximum production.

With the exception of the six registered animals, and some of the younger animals which were raised by the station, these cows are "farmers' cows," bought by a Vermont farmer at moderate prices, from farmers' herds within the limits of a single Vermont town. It is clear that such cows are better worth $50.00, the approximate average price paid, than is the average Vermont cow, which gives but little over 150 pounds of butter a year, worth a quarter of that sum. It is entirely practicable for a good judge of cows to get together such a herd by the expenditure of some time, trouble and a moderate amount of money. It is hoped that the study of this record by Vermont farmers will lead many to breed better cows, to feed good cows better, and to cull out unprofitable animals.

FEEDING RECORD, NOVEMBER 1, 1897–OCTOBER 31, 1898

NAME OF COW	Hay	Silage	Oats and peas	Corn meal	Wheat bran	½ cotton-seed ½ linseed	Atlas gluten meal	Gluten meal	Sundries (See footnote)
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Acme 5th 10342 A. R.	4867	4089	218	248	1337	30	30	40	43*
Annie	3974	1515	184	523	437	265	31	40	
Atalanta 10777 A. R.	3575	4294	164	479	518	329	146	32	
Bess	4266	2665	171	1363	1373	64	29	37	
Bettie	5101	2856	209	681	712	52	25	32	
Brownie	4058	4771	185	733	842	348	26	35	
Carmen	4463	5415	194	919	979	388	148	30	
Ceres	4290	5188	185	520	635	267	446	39	
Clare	4558	5512	199	846	926	268	24	33	
Clover	4303	4514	193	785	881	307	24	32	
Cressy	2078	3441		355	440	295	360		
Dandelion	5329	2699	208	626	737	316	30	40	26‡
Dora	3566	3979	180	784	909	324	266	32	
Edna	1046	571	8	217	216				
Eulalie	3340	5109	204	306	400	316	578	32	22‡
Eva	1065	576	10	193	192				52†
Fairie	4413	3209	169	712	776	222	30	39	52¶
Flora	4374	4665	205	747	864	387	36	49	
Flox	4165	5439	215	927	848	247	38	51	
Foolie	1631	543	195	397	396	11	10	13	
Golden Rod	5505	3849	194	503	585	197	230	40	
Goldie	4189	4422	190	882	955	411	149	32	
Haidee	881	574	9	174	174				52†
Idarella	5370	2926	191	1044	1206	86	31	41	
Inez	1033	575	11	211	216				
Jeannie	4672	2950	184	751	856	305	25	32	
Jersey Lily	5155	3558	203	598	712	348	31	41	52¶
Jessie	1402	2271		118	177	177			
Kittie	663	531	17	17	14	13		17	
Lady Perusia 123228 A. J. C. C.	4068	1981	162	432	608	449	178	42	
Lala	3442	3529	173	568	671	333	24	32	
Maizie	2891	3457	176	633	557	267	153	38	
Marjory	4306	5070	185	568	646	341	535	38	
Max Belle 108996 A. J. C. C.	4560	2542	190	756	671	277	23	30	
Max Ella	4423	4739	188	764	865	311	25	34	
Minta Bella 85578 A. J. C. C.	5327	2152	189	292	1296	84	42	56	41*
Nancy B	4017	5186	208	385	561	263	466	40	
Naomi 9581 A. R.	4350	2175	178	902	901	25	25	34	
Orpha	1073	577	6	200	206	19			
Pauline	3617	3666	187	687	650	331	24	32	
Polela	4435	4478	196	578	736	310	444	32	
Polly	5437	3057	185	276	1721	58	26	36	42*
Pomona	4339	5055	188	622	754	272	382	39	
Priscilla	4724	2261	185	750	850	330	32	43	
Pussy Willow	4542	5127	184	581	691	269	414	31	
Rachel	3816	3380	179	605	714	347	23	31	11†
Red Top	5543	3852	217	346	1281	73	31	41	49*
Regina	2016	2450		394	591	591			
Rose	3918	871	133	401	271	355	139	37	
Rowena	5276	2688	213	610	326	292	30	40	
Ruth	3840	3922	100	758	1032	257	23	31	
Salida	4105	4507	204	734	703	330	24	32	
Sue	1873	579	245	216	230	22			

*Cottonseed oil. †Buffalo gluten feed. ‡Buckwheat middlings. ¶Oat feed.

SUNDRY FORAGE CROPS

Six non-saccharine sorghums and leguminious crops were grown in a small way in 1898. The stands of the former were not particularly satisfactory; of the latter, fair. None of the sorghums had arrived at full maturity when harvested, the intention being to hay rather than to thrash them. The several varieties are arranged in the table of analyses according to their respective yields.

ANALYSES OF NON-SACHARINE SORGHUMS AND LEGUMES

PLOT	Original substance		Composition of dry matter							
	Water	Dry matter	Crude ash	Crude protein	Crude fiber	Nitrogen-free extract	Ether extract	Nitrogen	Phosphoric acid	Potash
Milo maize	75.23	24.77	7.60	8.94	24.98	56.76	1.72	1.43	0.40	2.15
Brazilian corn	79.02	20.98	8.36	8.80	19.50	61.90	1.44	1.41	0.36	2.12
Jerusalem corn	73.14	26.86	6.52	8.80	26.96	56.07	1.65	1.41	0.53	2.13
Brown dourrha	68.75	31.25	6.35	10.40	24.32	56.81	2.12	1.66	0.55	1.73
African millet	74.59	25.41	6.87	9.14	27.33	54.72	1.94	1.46	0.55	2.16
Black rice corn	72.64	27.36	6.06	8.18	27.50	56.56	1.70	1.31	0.33	2.02
Soy bean	69.78	30.22	11.88	15.20	20.50	48.42	4.00	2.43	0.70	1.91
Russian vetch, '96	71.96	28.04	12.03	20.32	23.56	40.84	3.25	3.25	0.77	2.96
Russian vetch, '97	71.67	28.33	11.08	16.95	25.47	43.25	3.25	2.71	0.69	3.74

Non-saccharine sorghums.—This class of crop is better adapted to semi arid regions and to latitudes further south than Vermont. Their strong point is that of drought resistance. There seems to be no good reason for thinking that they can compete successfully with such varieties of maize and of millet as are adapted to the climate and soil of this locality.

Legumes.—The soy bean (soja bean) has been grown here for some years, has been referred to in previous station publications and seems a fairly promising forage crop, particularly if planted with corn. The vetches were from seed supplied by the United States department of agriculture and imported from Russia. In these trials they seemed to do no better if as well as did crops grown in former years from domestic seed.

THE EFFECT OF FATIGUE UPON THE QUANTITY AND QUALITY OF MILK

The results of two experiments showing the effect of travel upon the milk flow have been published in former years by the station.[1] Further opportunity to add to our knowledge touching this matter having arisen, the following records were made:

Six new milch cows were driven some 10 miles, shipped by rail 70 miles, arriving at destination at midnight about 18 hours after starting. They were not milked during this time. Samples were taken of the third and fourth milking after arrival of four days a week later and of four days three weeks later.

The following table shows the yield and percentages of milk, solids, and solids-not-fat on the day after arrival and average daily yields and percentages one and three weeks later:

	Milk lbs.	Total solids %	Fat %	Solids-not-fat %	Total solids lbs.	Fat lbs.	Solids-not-fat lbs.
Day after arrival	122.5	15.19	5.94	9.25	18.6	7.3	11.3
One week later	122.3	13.73	4.43	9.30	16.8	5.3	11.4
Three weeks later	131.4	14.10	4.82	9.28	18.5	6.3	12.2

The cows as a whole gave about the same quantity of milk on the day after arrival that they did later. Its quality was far richer, however, at first than it was after some time had elapsed. Considering each animal individually it was found that three gave more, one less, and two the same yield after becoming accustomed to their new quarters; that the fat percentages were less in each case; and that the solids-not-fat were irregular, two increasing and one decreasing decidedly as time went on.

The character of the milk of the cow Pretoria on her third milking was positively abnormal in that it contained more fat than solids-not-fat. She gave 8.8 pounds of milk containing 17.31 per cent total solids, 8.78 per cent fat, 8.53 per cent solids-not-fat, 28 lactometer reading. During the month following she gave about 10 pounds to a milking, testing 4.05 per cent fat.

In the trials previously reported temporary milk shrinkage was observed. This was not seen to any great extent in the present tests. In all cases, as in the present instance, temporary enrichment ensued. The outcome of this series of tests clearly shows the folly of testing a cow's milk before she becomes 'at home' in new quarters and has recovered from fatigue.

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1 Vt. Sta. Rpts. 8, pp. 162-163, (1894), 11, pp. 367-368 (1898).

APPENDIX CONTAINING CONDENSED DATA PERTAINING TO ARTICLE ON FEEDING TESTS AND THEIR METHODS.

I. Weights of cows.

II. Average barn temperatures, with ranges and percentages of uniformity.

III. Analyses and digestible ingredients in fodders and feeds: (*a*) analyses on dry basis; (*b*) digestion co-efficients; (*c*) pounds of digestible nutrients in 100 pounds of original substance.

IV. Feeding records of the individual cows in feeding tests.

V. Production records; showing production and same per unit for each individual cow in feeding tests.

VI. Difference tables. (*a*) Total of differences; (*b*) Percentage differences.

VII. Results of experimental feeding on different rations.

I. WEIGHTS OF COWS

	Sue	Haidee	Atalanta	Nancy B	Goldie	Eva	Acme	Golden Rod	Jersey Lily	Viola
I	985	693	----	----	1020	814	----	1007	912	----
I	993	743	930	1032	1046	831	----	1038	970	----
II	1003	735	943	1062	1023	837	995	1032	974	----
III	1017	760	918	1072	1034	898	952	1038	955	647
IV	1038	765	943	1080	1033	925	923	----	----	642
V	1100	795	962	1098	1030	928	915	----	----	650
VI	1118	799	983	1102	1028	----	920	----	----	678

	Jeannie	Clover	Eulalie	Rose	Lala	Dime	Edna	Annie	Ceres	Rowena
I	----	----	----	----	----	----	890	----	818	886
I	----	----	1040	650	803	----	921	885	862	919
II	----	----	1048	642	779	----	898	880	870	872
III	----	----	1077	690	802	792	920	928	882	940
IV	----	----	1102	728	803	807	948	978	925	964
V	845	1022	1123	732	----	816	962	988	----	----
VI	829	987	----	----	----	----	----	----	----	----
VII	768	978	----	----	----	----	----	----	----	----
VIII	----	945	----	----	----	----	----	----	----	----

	Red Top	Marjory	Bettie	Fairie	Minta Bella	Flora	Dandelion	Polela	Pauline	Inez
I	987	858	1008	877	----	----	----	----	----	750
I	1000	902	1033	895	----	----	----	----	----	787
II	1011	853	1055	915	747	----	----	----	775	743
III	1038	885	1070	913	758	----	----	860	800	768
IV	1108	903	----	----	760	1007	----	868	783	760
V	----	947	----	----	788	962	863	883	798	727
VI	----	----	----	----	800	935	835	885	----	720
VII	----	----	----	----	----	913	817	----	----	----
VIII	----	----	----	----	----	----	850	----	----	----

	Priscilla	Sylvia	Adah	Maizie	Salida	Naomi	Max Ella	Orpha	Hazel	
I	----	908	----	----	----	----	----	----	----	
I	850	928	----	----	----	----	----	----	----	
II	838	905	607	----	----	----	954	----	----	
III	868	883	673	937	----	----	925	----	598	
IV	862	923	718	928	----	732	937	----	618	
V	880	965	758	941	968	732	930	883	648	
VI	----	997	758	923	972	715	937	875	627	
VII	----	----	----	----	965	718	----	920	665	
VIII	----	----	----	----	980	----	----	935	----	

	Lilac	Clare	Pussy Willow	Leah	Polly	Pomona	Bonny Belle	Rachel	Star Bright	Max Belle
I	----	----	----	----	----	----	----	----	----	858
I	----	----	----	----	----	----	----	----	----	905
II	----	----	----	----	----	----	----	785	735	921
III	----	----	----	----	----	----	----	787	773	958
IV	683	935	----	722	910	835	807	810	782	982
V	692	973	790	757	873	830	855	823	795	1007
VI	678	951	795	780	830	833	843	800	807	1015
VII	705	943	820	811	896	833	857	----	----	----

II. AVERAGE BARN TEMPERATURES, WITH RANGES AND PERCENTAGES OF UNIFORMITY

	5 AM	12 M	6 PM	5 AM	12 M	6 PM	5 AM	12 M	6 PM		5 AM	12 M	6 PM	5 AM	12 M	6 PM	5 AM	12 M	6 PM
	Cows fed in 4-week periods										Cows fed in 5-week periods								
LARGE BARN																			
I	—	—	—	—	—	—	—	—	—	I	—	—	—	—	—	—	—	—	—
	56	53	55	50-60	48-57	52-58	71	86	100		55	52	54	49-60	46-57	50-58	57	81	73
II	54	51	52	49-58	48-55	50-56	50	80	90	II (oil)	53	52	53	48-58	38-55	44-56	50	70	60
	50	49	51	45-58	38-58	44-56	44	67	67		51	49	51	45-58	38-55	44-56	39	61	72
III	53	48	50	48-58	40-53	45-55	60	60	70	III(oil)	50	45	46	40-58	34-58	36-58	33	47	60
	51	47	48	40-60	34-58	36-58	22	37	50		50	46	49	45-60	34-58	40-55	52	48	67
IV	53	51	50	45-58	40-53	45-55	60	60	70	II	53	51	53	48-58	47-58	50-56	75	83	100
	46	43	46	40-50	34-51	40-51	55	55	61		50	48	50	40-58	34-58	36-58	33	52	65
V	53	48	49	44-58	35-54	40-54	30	40	80	III	51	45	48	43-58	39-52	40-53	30	57	50
	54	50	52	49-59	42-58	46-59	62	56	61		50	46	49	40-60	34-58	40-55	57	57	70
VI	51	48	51	48-58	45-52	48-54	70	90	90	IV	48	42	55	40-58	35-49	40-51	33	50	67
	55	52	53	50-58	45-56	48-56	89	67	95		54	50	52	48-59	42-58	46-56	70	61	65
VII	59	57	58	54-62	50-68	52-65	90	70	50	V	51	48	51	48-58	45-52	48-54	67	83	100
	60	65	67	52-70	52-80	58-78	61	44	44		56	53	54	50-62	46-60	48-62	77	65	70
VIII	59	62	62	55-66	54-70	53-70	70	30	70	VI	59	62	65	56-63	56-73	58-75	92	42	67
	64	68	69	55-80	58-83	58-83	33	22	39		60	63	64	54-70	54-80	53-78	61	26	30
SMALL BARN																			
I	—	—	—	—	—	—	—	—	—	I	—	—	—	—	—	—	—	—	—
	55	54	55	48-60	46-60	49-60	73	50	71		53	51	52	44-60	43-60	46-60	46	46	36
II	50	53	54	42-58	43-58	46-60	30	60	70	II (oil)	51	54	53	42-57	52-56	50-57	60	100	90
	51	52	53	42-58	41-57	44-59	44	83	89		51	51	53	42-60	41-57	44-59	22	56	83
III	54	51	54	42-60	45-56	46-58	60	40	70	III(oil)	51	49	49	39-60	40-58	38-60	13	40	27
	52	50	51	39-62	40-58	38-60	22	50	33		51	51	51	41-62	44-56	45-58	56	67	67
IV	52	52	53	47-57	47-56	47-56	80	70	90	II	52	53	54	42-58	52-56	51-59	58	100	83
	45	48	48	35-52	42-55	40-54	33	56	67		50	50	52	42-60	40-58	38-60	22	39	48
V	54	51	52	45-60	42-57	47-58	40	50	60	III	52	50	51	39-60	40-58	41-58	25	67	42
	53	53	54	47-58	47-60	48-58	56	72	72		51	51	51	41-62	40-56	45-58	61	65	65
VI	52	52	53	42-60	45-56	50-58	50	70	90	IV	47	47	49	35-60	42-57	40-58	42	58	42
	56	54	55	50-60	49-60	51-58	78	67	94		53	53	53	47-59	47-60	48-58	61	74	78
VII	58	61	63	52-62	52-70	51-70	70	70	40	V	53	51	53	42-60	45-56	50-58	50	58	92
	61	70	70	54-74	59-80	63-80	50	50	50		57	58	57	52-60	49-62	51-68	96	70	70
VIII	57	66	65	51-60	55-72	55-72	90	50	50	VI	61	68	69	54-74	58-76	59-76	58	50	58
	64	70	71	55-80	62-83	62 83	33	17	33		59	67	67	51-70	55-80	55-80	74	39	52

III. ANALYSES AND DIGESTIBLE INGREDIENTS IN FODDERS AND FEEDS

(*a*) ANALYSES ON DRY BASIS; (*b*) DIGESTION COEFFICIENTS; (*c*) POUNDS OF DIGESTIBLE NUTRIENTS IN ONE HUNDRED POUNDS OF ORIGINAL SUBSTANCE

(*a*) ANALYSES ON DRY BASIS

Fodders and feeds	Dates of sampling	Original substance		Composition of dry matter						
		Water	Dry matter	Crude ash	Crude protein	Crude fiber	Nitrogen-free extract	Ether extract	Nitrogen	Phosphoric acid	Potash
Hay	A	12.75	87.25	8.28	9.78	32.78	47.19	1.97	1.57	.71	2.16
	B	12.67	87.33	8.15	10.64	34.91	44.44	1.86	1.70	.56	1.85
	C	13.35	86.65	8.01	9.37	33.24	47.61	1.77	1.50	.60	1.86
	D	12.77	87.23	7.47	9.79	34.66	46.20	1.88	1.57	.53	1.91
Silage	A	69.30	30.70	6.13	8.18	22.94	60.11	2.64	1.31	.62	1.27
	B	71.91	28.09	7.01	9.05	21.23	59.88	2.83	1.45	.59	1.57
	C	70.82	29.18	7.39	9.07	19.10	61.19	3.25	1.45	.65	1.60
	D	68.99	31.01	8.80	9.26	19.92	58.75	3.27	1.48	.53	1.65
Artichoke tops	E	25.75	74.25	9.47	5.66	29.56	54.07	1.24	0.91	.39	1.41
Artichokes	F	79.74	20.26	7.29	10.08	3.66	78.71	.26	1.61	.62	1.95
	G	77.95	22.05	7.68	9 68	3.77	78.2	.58	1.55	.67	2.41
	H	76.61	23.39	10.33	9.45	4.16	75.76	.30	1.51	.61	2.41
	I	75.73	24.27	15.26	10.67	4.42	68.63	1.02	1.71	.62	2.20
Sugar beets	K	76.42	23.58	16.06	5.08	5.95	72.45	0.46	.81	.38	1.33
	L	76.66	23.34	19.74	5.50	6.14	68.01	0.61	.88	.40	1.26
	M	80.63	19.37	16.33	6.40	6.50	70.46	0.31	1.02	.41	1.97
Mixed feed No. 1	A	8.90	91.10	6.34	24.22	8.29	55.50	5.65	3.88	2.46	1.65
	B	8.50	91.50	6.40	24.92	8.58	53.76	6.34	3.99	2.45	1.65
	C	8.35	91.65	5.98	24.16	8.60	54.82	6.44	3.87	2.51	1.64
	D	8.35	91.65	5.71	27.08	6 82	54 17	6.22	4.33	2 44	1.44
Mixed feed No. 2	A	8.50	91.50	7.04	26.07	8.63	52.85	5.41	4.17	2.79	1.81
	B	8.10	91.90	6.88	26.66	9.63	50.46	6.37	4.27	2.83	1.77
	C	8.15	91.85	6.18	26.67	9.23	51.44	6 48	4.27	2.78	1.72
	D	8.20	91.80	5.99	28.66	7.52	51.68	6.15	4.59	2.56	1.67
Mixed feed No. 3	A	9.35	90.65	5 71	19.24	7.53	61.62	5.90	3.08	2.48	1.45
	B	9.20	90.80	5.60	19.27	6.66	62.74	5.73	3.08	2.45	1.46
	C	9.30	90.70	5.67	20.42	6.67	61.18	6.06	3.27	2.36	1.48
	D	9.50	90.50	5.18	20.10	5.90	62.96	5.86	3.22	2.14	1.35
Mixed feed No. 4	A	9.60	90.40	4.49	14.07	6.25	70.16	5.03	2.25	2.04	1.28
	B	8.80	91.20	4.86	13 85	7.42	68.44	5.43	2.22	1.96	1.30
	C	8.85	91.15	4.41	13.17	5.98	71.28	5.16	2.11	1.91	1.18
	D	8.55	91.45	4.41	13.39	6.51	70.28	5.41	2.14	1.88	1.13
Mixed feed No. 5	A	8.85	91.15	4.10	12.89	5.52	72.50	4.99	2.06	1.79	1.10
	B	9.00	91.00	3.60	12.91	5.71	72.89	4.89	2.07	1.57	1 08
	C	8.85	91.15	3.55	12.41	5.05	74.00	4.99	1.99	1.68	0.97
	D	9.20	90.80	3.81	12.81	5.51	73.08	4 79	2.05	1.57	1.04
Wheat bran	A	8.40	91.60	7.78	16.25	11.57	59.16	5.24	2.60	3.57	2.05
	B	8.75	91.25	7 39	16.58	12 09	58.73	5.21	2.65	3.30	2.01
	C	8.35	91.65	7.42	16.91	11.67	58.43	5.57	2.71	3.34	2.01
	D	8.60	91.40	6.86	16.99	10.28	60.02	5.85	2.72	3.16	1.77
Buckwheat middlings	A	9.15	90.85	4.95	22.43	2.64	63.43	6.55	3.59	2.24	1.09
	B	9.65	90.35	4.79	23.45	3.67	61.39	6.70	3.75	2.26	1.11
	C	9.15	90.85	4.41	24.08	5.34	60.28	5.89	3.85	1.84	0.97
	D	9.25	90.75	4.33	21.76	4.50	63.79	5.62	3.48	1.84	0.80

Fodders and feeds	Dates of sampling	Original substance		Composition of dry matter							
		Water	Dry matter	Crude ash	Crude protein	Crude fiber	Nitrogen-free extract	Ether extract	Nitrogen	Phosphoric acid	Potash
Quaker oat feed	A	9.10	92.90	5 86	10.83	18.06	61.10	4.15	1.73	0.94	0.71
	B	7.35	92.65	5.98	11.13	17.76	61.14	3.99	1.78	0.86	0.75
	C	6.65	93.35	5.89	11.04	18.91	59.77	4.39	1.77	0.88	0.77
	D	7.15	92.85	5.36	11.04	17.12	62.39	4.09	1.77	0.85	0.76
Corn meal	A	9.70	90 30	1.64	10.46	1.86	81.61	4.43	1.67	0.66	0.41
	B	10.50	89.50	1.74	11.24	2,10	80.79	4.13	1.80	0.64	0.45
	C	9.35	90.65	1.51	9.93	1.52	82.76	4.28	1.59	0.63	0.38
	D	10.00	90.00	1.80	10.14	1.76	81.97	4.33	1.62	0.52	0 43
Cottonseed meal	A	9.20	92.80	7.86	47.69	5.17	27.97	11.31	7.63	3.42	2.00
	B	7.80	93.20	7.72	46.67	5.63	27.21	12.77	7.47	3.50	2.05
	C	6.55	93.45	7.60	46.54	6.69	27.69	11.48	7.45	3.17	2.16
	D	6.75	93.25	8.39	47.93	5.55	27.91	10.22	7.67	3.18	2.28
Linseed meal	A	8.15	91.85	6.97	38.04	10.16	43 20	1.63	6.09	1.89	1.59
	B	8.15	91.85	6.80	39.13	9.83	42.00	2.24	6.26	2.07	1.55
	C	7.80	92.20	6.94	40.53	9.90	40.28	2.35	6.49	1.95	1.51
	D	8.15	91.85	6.68	40.55	9.58	40.30	2.89	6.49	2.00	1.45
Buffalo gluten meal	A	8.10	91.90	3.86	27.62	6.96	58.62	2.94	4.42	1.19	0.60
	B	8.15	91.86	3.83	27.15	7.00	58.86	3.16	4.34	1.20	0 65
	C	7.80	92.20	3.87	27.32	7.54	58 18	3.09	4.37	1.18	0.61
	D	7.25	92.75	4.37	27.29	6.95	58.32	3.07	4.37	1.23	0.58

1 Samples were taken at fortnightly intervals, silages in quadruplicate, hays in triplicate, grain feeds and mixtures, singly. The roughage and concentrate samples, 359 in number, were separately analyzed for dry matter and combined into 64 samples for complete analyses as indicated in the table. In calculating total dry matter and digestible ingredients eaten—as in tables IV and V—the analyses of the individual samples were used for the appropriate periods.

The letters A to M inclusive indicate days of sampling. The analyses labelled A were made on composite samples of samples taken Oct. 26, Nov. 7 and 21, and Dec. 5; B, Dec. 19, Jan. 2, 16, 30; C, Feb. 13, 27, March 13, 27; D, April 10, 24, May 8, 22; E, Dec. 5, 19, Jan. 2; F, Dec. 5, 19; G, Jan. 2, 16; H, Jan. 30, Feb. 13; I, Feb. 27; K, Jan. 16, 30; L, Feb. 13, 27; M, March 13, 27, April 10.

The formulas for the mixed feeds are shown by footnote on page 260.

(*b*) DIGESTION COEFFICIENTS [1]

	Dry matter	Protein	Crude fiber	Nitrogen-free extract	Ether extract
Hay	58	53	56	61	54
Silage	75	65	77	79	82
Artichoke tops, [2]	71	65	76	73	70
Artichokes [3] / Sugar beets [3]	95	91	100	100	50
Mixed feed No. 1, [4]	74	83	26	79	84
" " " 2, [4]	72	84	27	75	83
" " " 3, [5]	—	—	—	—	—
" " " 4, [4]	74	72	19	83	78
" " " 5, [4]	79	69	17	87	83
Wheat bran	61	79	22	69	68
Buckwheat middlings, [5]	—	—	—	—	—
Quaker oat feed	70	78	20	76	83
Corn meal	88	60	—	93	92
Cottonseed meal	76	88	—	64	93
Linseed meal (N. P.)	79	89	57	78	89
Buffalo gluten feed	84	85	72	87	83

1 From tables of digestibility of American feeding stuffs published by Lindsey, Mass. Sta. Rpt. 9, pp. 158-170 (1896); and by Jordan, Exp. Sta. Rcd. 6, pp. 5-8 (1894-95).

2 Assumed to be the same as corn fodder.

3 Assumed same as beets.

4 Calculated from analyses of their ingredients and from digestion coefficients of the same.

5 No digestion experiments on buckwheat middlings have as yet been made.

(c) POUNDS OF DIGESTIBLE NUTRIENTS IN ONE HUNDRED POUNDS OF ORIGINAL SUBSTANCE

Fodders and feeds	Dates of sampling (See footnote p. 314)	Digestible nutrients				
		Dry matter	Protein	Crude fiber	Nitrogen-free extract	Ether extract
Hay	A	50.60	4.52	16.02	25.11	0.93
	B	50.65	4.92	17.07	23.67	0.87
	C	50.26	4.30	16.13	25.16	0.83
	D	50.60	4.53	16.93	24.58	0.89
Silage	A	23.02	1.63	5.42	14.58	0.66
	B	21.07	1.65	4.59	13.29	0.66
	C	21.88	1.72	4.29	14.11	0.80
	D	23.26	1.87	4.76	12.59	0.83
Artichoke tops	E	52.72	2.73	16.68	29.31	0.64
Artichokes	F	19.25	1.86	0.74	15.95	0.03
	G	20.95	1.94	0.83	17.26	0.07
	H	22.22	2.01	0.97	17.72	0.04
	I	23.06	2.36	1.07	16.66	0.13
Sugar beets	K	22.40	1.09	1.40	17.08	0.06
	L	22.17	1.16	1.43	15.87	0.07
	M	18.40	1.13	1.26	13.65	0.03
Mixed feed No. 1	A	67.41	18.31	1.96	40.73	4.33
	B	67.71	18.93	2.04	38.85	4.87
	C	67.82	18.38	2.05	39.70	4.96
	D	67.82	20.54	1.63	39.22	4.79
Mixed feed No. 2	A	65.88	20.03	2.13	36.27	4.11
	B	66.17	20.58	2.39	34.79	4.86
	C	66.13	20.58	2.29	35.43	4.94
	D	66.10	22.10	1.86	35.58	4.69
Mixed feed No. 4	A	66.90	9.16	1.07	52.64	3.55
	B	67.49	9.09	1.29	51.80	3.86
	C	67.45	8.64	1.04	53.93	3.67
	D	67.67	8.82	1.13	53.34	3.86
Mixed feed No. 5	A	72.01	8.11	0.86	57.49	3.78
	B	71.89	8.11	0.88	57.70	3.68
	C	72.01	7.80	0.78	58.68	3.78
	D	71.74	8.02	0.85	57.73	3.61
Wheat bran	A	55.87	11.75	2.33	37.38	3.26
	B	55.66	11.95	2.43	36.98	3.23
	C	55.90	12.24	2.35	36.95	3.47
	D	55.75	12.25	2.07	37.87	3.64
Quaker oat feed	A	65.03	7.85	3.35	43.68	2.61
	B	64.88	8.04	3.29	43.25	3.07
	C	65.35	8.04	3.53	42.40	3.40
	D	65.00	7.99	3.18	44.03	3.15
Corn meal	A	79.46	5.66	----	68.54	3.68
	B	78.76	6.04	----	67.24	3.40
	C	79.78	5.40	----	69.76	3.57
	D	79.20	5.48	----	68.60	3.59
Cottonseed meal	A	70.52	38.94	----	16.61	9.77
	B	70.83	38.28	----	16.23	11.07
	C	71.03	38.28	----	16.56	9.98
	D	70.87	39.34	----	16.97	9.50
Linseed meal N. P.	A	72.56	31.10	5.32	30.95	1.34
	B	72.56	31.98	5.15	30.08	1.83
	C	72.84	33.26	5.20	28.96	1.93
	D	72.56	33.15	5.02	28.87	2.36
Buffalo gluten meal	A	77.20	21.57	4.61	46.87	2.24
	B	77.16	21.20	4.63	47.04	2.41
	C	77.28	21.41	5.00	46.67	2.37
	D	77.92	21.51	4.64	47.06	2.37

IV. FEEDING RECORDS OF INDIVIDUAL COWS

EQUAL BALANCE (Medium nutritive ratios)		Pounds eaten of								Pounds of digestible nutrients eaten during period					
SUE, HAIDEE, ATALANTA, NANCY B	Nature of ration	Hay	Corn meal	Wheat bran	½ cottonseed ½ linseed	Buffalo gluten feed	Silage	Total dry matter in entire ration	Total dry matter in experimental feed	Dry matter	Protein	Crude fiber	Nitrogen-free extract	Ether extract	Nutritive ratio, 1:
Period numbers and dates															
I. Pre. Oct. 25-Nov. 6	II	163	13	39	39	...	222	295.8	82.2	192.2	29.1	40.0	106.1	6.7	5.6
Exp. Nov. 6-29	II	336	23	67	68	4	523	599 7	146.7	398.6	56.1	85.6	219.5	13.3	6.0
II. Pre. Nov. 29-Dec. 11	B G	177	...	...	...	96	278	324.3	87.9	227.2	33.2	47.9	130.0	5.7	5.8
Exp. Dec. 11-Jan. 3	B G	317	...	...	...	184	504	591.4	168.9	409.8	62.9	85.7	228.6	10.5	5.4
III. Pre. Jan. 3-15	II	176	10	31	31	8	254	296.3	72.9	194.8	29.4	43.6	103 3	7.1	5.5
Exp. Jan. 15-Feb. 7	II	351	23	69	69	...	535	601.9	146.6	396.6	59.2	88.3	210.2	14.4	5.6
IV. Pre. Feb. 7-19	B G	181	...	...	...	96	265	330.8	88.9	224.1	33.0	45.4	127.7	5.9	5.7
Exp. Feb. 19-Mch. 14	B G	320	...	...	...	184	528	600.4	170.4	418.9	62.3	83.5	240.9	11.3	5.6
V. Pre. Mch. 14-26	II	180	12	36	36	...	288	312.6	76.6	208.5	30.0	43.4	115.7	7.9	5.9
Exp. Mch. 20-Apr. 18	II	354	23	69	69	...	550	612.3	146.1	413.0	55.0	86.7	218.7	15 3	6.0
VI. Pre. Apr. 18-30	B G	173	...	...	...	96	286	328.0	88.1	229.5	33.9	47.4	123.7	6.2	5.6
Exp. Apr. 30-May 23	B G	318	...	...	...	184	543	616.5	168.6	431.0	64.2	88.2	233 2	11.7	5.4
I. Pre. Oct. 25-Nov. 6	B G	123	...	...	...	91	210	258.6	83.5	180.1	28.6	35.3	104.3	4.5	5.3
Exp. Nov. 6-29	B G	254	1	2	1	158	448	506.2	147.9	357.7	53.7	72.5	205.0	9.0	5.6
II. Pre. Nov. 29-Dec. 11	II	127	12	36	36	...	240	258.2	76.5	174.6	26.4	35.1	97.4	6.3	5 6
Exp. Dec. 11-Jan. 3	II	242	23	69	69	...	460	492.2	148.1	326.8	52.6	66.3	174.4	12.9	5.2
III. Pre. Jan. 3-15	B G	131	2	3	2	88	233	265.9	87.2	188.2	30.4	37.5	106.7	4.9	5.2
Exp. Jan. 15-Feb. 7	B G	256	...	...	...	184	450	517.7	168.9	366.2	59.0	72.9	207.0	9.6	5.2
IV. Pre. Feb. 7-19	II	139	12	36	36	...	230	270.8	76.8	176.3	27.3	34.2	97.3	7.2	5.4
Exp. Feb. 19-Mch. 14	II	253	23	69	69	...	460	500 3	148.1	334.6	51.9	64.2	185.6	13.8	5.4
V. Pre. Mch. 14-26	B G	129	...	...	...	96	237	266.6	88.8	190.6	30.3	35.8	110.7	5.3	5.3
Exp. Mch. 20-Apr. 18	B G	251	...	...	...	181	447	514.8	167.5	366 9	57.9	70.5	206.9	10.2	5.3
VI. Pre. Apr. 18-30	II	139	12	36	36	...	239	271.7	76.2	182.0	29.4	36.5	94.2	7.1	5.0
Exp. Apr. 30-May 23	II	245	23	69	69	...	458	503.6	146.1	337.2	55.3	66.3	175.2	14.0	4.9
II. Pre. Nov. 29-Dec. 12	B G	179	...	...	...	96	285	328.1	87.9	229.8	33.5	48.5	131.6	5.8	5.8
Exp. Dec. 12-Jan. 3	B G	350	...	...	...	184	598	647.3	168.9	446.4	66.1	95.7	249.0	11.5	5.6
III. Pre. Jan. 3-15	II	180	11	33	33	4	240	296.8	73.8	195.2	29.8	43.7	103.0	7.2	5.5
Exp. Jan. 15-Feb. 7	II	363	23	69	69	...	545	615.1	146.6	404.7	60.0	90.8	214.3	14.6	5.8
IV. Pre. Feb. 7-19	B G	186	...	...	...	96	284	341.1	88.9	230.7	33.5	47.0	131.7	6.1	5.7
Exp. Feb. 19-Mch. 14	B G	337	...	...	...	184	544	619.8	170.4	431.0	63.3	86.9	247.5	11.6	5.7
V. Pre. Mch. 14-26	II	184	12	36	36	...	287	315.7	76.6	210.2	30.1	43.9	116.6	7.9	5.9
Exp. Mch. 20-Apr. 18	II	358	23	69	69	...	550	615.8	146.1	409.5	60.1	87.4	219.6	15.4	5.7
VI. Pre. Apr. 18-30	B G	178	...	...	...	96	288	333.0	88.1	232.6	34.2	48.3	125.3	6.3	5.5
Exp. Apr. 30-May 23	B G	306	...	...	...	184	548	607.7	168.6	426.2	63.8	86.4	230.8	11.7	5.4
II. Pre. Nov. 29-Dec. 12	II	229	12	36	36	...	286	360.4	76.5	234.0	31.6	54.1	127.0	7.9	6.3
Exp. Dec. 12-Jan. 3	II	431	23	69	69	...	629	706.6	148.1	458.7	64.7	106.3	240.6	15.8	6.0
III. Pre. Jan. 3-15	B G	216	...	...	...	88	336	368.3	87.2	247.2	34.8	56.4	137.2	6.2	6;0
Exp. Jan. 15-Feb. 7	B G	441	...	...	...	184	656	736 5	168.9	503.1	71.5	113.9	278.2	12.5	5.9
IV. Pre. Feb 7-19	II	228	12	36	36	...	345	384.9	76.8	246.7	33.0	53.5	135.9	8.9	6.3
Exp. Feb. 19-Mch. 14	II	391	23	69	69	...	668	679.2	147.1	449.7	61.4	95.5	249.7	16.6	6.2
V. Pre. Mch. 14-26	B G	223	...	...	...	96	354	380.4	88 8	265.6	36 3	56.0	150.9	7.0	6.2
Exp. Mch. 20-Apr. 18	B G	431	...	...	...	184	679	740.6	170.2	511.5	70.8	111.0	284.0	13.7	6.0
VI. Pre. Apr. 18-30	II	219	12	36	36	...	350	376.2	76.2	248.6	35.0	55.4	127.8	8.8	5.8
Exp. Apr. 30-May 23	II	393	23	69	69	...	671	699.7	146.1	461.9	66.0	101.4	238.4	17.1	5.7

EQUAL BALANCE (Medium nutritive ratios)		Pounds eaten of								Pounds of digestible nutrients eaten during period					
GOLDIE, EVA, ACME	Nature of ration	Hay	Corn meal	Wheat bran	½ cottonseed ½ linseed	Buffalo gluten feed	Silage	Total dry matter in entire ration	Total dry matter in experimental feed	Dry matter	Protein	Crude fiber	Nitrogen-free extract	Ether extract	Nutritive ratio, 1:
Period numbers and dates															
I. Pre. Oct. 25–Nov. 6	II	183	12	36	36	...	232	310.4	76.3	197.8	28.6	43 8	107.6	7.1	5.8
Exp. Nov. 6-29	II	384	23	67	68	4	548	649.4	146.7	428.8	58.7	94.7	235.1	13.9	6.2
II. Pre. Nov. 29-Dec. 11	B G	180	...	...	...	96	285	329.0	87.9	230.4	33.5	48.6	131.8	5.8	5.8
Exp. Dec. 11-Jan. 3	B G	313	...	...	...	184	538	597.7	168.9	405.9	63.3	86.6	232.2	10.7	5.4
III. Pre. Jan. 3-15	II	168	11	33	33	8	259	295.4	77.5	195.2	30.1	42.6	103.8	7.3	5.4
Exp. Jan. 15-Feb 7	II	343	23	69	69	...	542	596.9	146.6	394.0	58.9	87.6	210.0	14.4	5.6
IV. Pre. Feb. 7-19	B G	171	...	...	...	96	278	326 0	88.9	221.8	32.8	44.3	127.0	5.9	5.6
Exp. Feb. 19-Mch. 14	B G	320	...	...	...	184	545	605.3	170.4	422.6	62.6	84.2	243.3	11.5	5.8
V. Pre. Mch. 14 26	II	172	12	36	36	...	264	299.0	76.6	199.3	29.2	40.9	110.4	7.6	5.7
Exp. Mch. 20-Apr. 18	II	354	23	68	68	...	488	592.4	144 3	392.2	58.4	83.9	209.6	14.7	5.6
VI. Pre. Apr. 18-30	B G	177	...	...	...	96	234	315.5	88.1	219.4	33.1	45.6	118.2	5.8	5.4
Exp. Apr. 30-May 23	B G	298	...	...	...	184	488	581.9	168.6	408.1	62.2	82.2	221.3	11.2	5.3
I. Pre. Oct. 25-Nov. 6	B G	158	...	...	...	96	234	301.2	88.0	207.0	31.6	42.4	118.8	5.2	5.5
Exp. Nov. 6-9	B G	33[2]	1	2	1	180	539	625.0	168.1	437.1	63.6	91.4	248.9	10.8	5.7
II. Pre. Nov. 29-Dec. 11	II	175	12	36	36	...	287	313.9	76.5	209.6	29.4	45.4	116.4	7 0	6.0
Exp. Dec. 11-Jan. 3	II	339	23	69	69	...	550	603.2	148.1	395.2	58.9	87.0	209.3	14 4	5.6
III. Pre. Jan. 3-15	B G	171	2	3	2	85	263	306.2	84.5	212.3	32.2	45.6	118.8	5.4	5.5
Exp. Jan. 15-Feb. 7	B G	329	...	...	...	183	529	602.5	168.0	419.0	63.7	89.0	234.3	10.8	5.5
IV Pre. Feb. 7 19	II	174	12	36	36	...	278	316.6	76.8	204.6	29.6	41.9	112.8	7.8	5.8
Exp. Feb. 19-Mch. 14	II	325	23	69	69	...	546	586.7	147.1	389.7	56.5	79.5	215.8	15.1	5.8
V. Pre. Mch. 14-16	B G	178	...	...	...	95	288	322.2	87.9	225.4	33.0	45.9	129.7	6.1	5.8
Exp. Mch. 20-Apr. 18	B G	334	...	...	...	176	544	610.1	162.8	426.4	62.4	88.3	238.2	11.6	5.7
III. Pre. Jan. 3-15	II	177	15	37	32	...	267	304.6	76.6	200.7	30.4	44.5	106.6	7.4	5.6
Exp. Jan. 15-Feb. 7	II	346	23	69	69	...	534	597.2	146.6	393.9	58.9	87.4	208.9	14.3	5.6
IV. Pre. Feb. 7-19	B G	177	...	...	...	96	256	324.4	88.9	220.0	32.6	44.4	125.4	5.8	5.6
Exp. Feb. 19-Mch. 14	B G	294	...	...	...	184	510	572.6	170.4	401.9	60.8	78.5	231.9	10.9	5.6
V. Pre. Mch. 14-26	II	172	12	36	36	...	281	303.7	76.6	203.0	29.5	41.7	112.8	7.7	5.8
Exp. Mch. 20-Apr. 18	II	333	23	69	69	...	525	586.9	146.1	391.4	58.6	82.1	210.1	15.0	5.5
VI. Pre. Apr. 18-30	B G	149	...	...	...	96	248	295.2	88.1	208.5	32.1	41 5	113.0	5.7	5.3
Exp. Apr. 30-May 23	B G	269	...	...	...	177	514	558.2	162.2	394.0	59.9	78.2	214.1	10.9	5.3

EQUAL BALANCE (Wide nutritive ratios)		Pounds eaten of								Pounds of digestible nutrients eaten during period					
GOLDENROD, JERSEY LILY, VIOLA, JEANNIE, CLOVER															
Period numbers and dates	Nature of ration	Hay	Corn meal	Wheat bran	½ cottonseed ½ linseed	Quaker oat feed	Silage	Total dry matter in entire ration	Total dry matter in experimental feed	Dry matter	Protein	Crude fiber	Nitrogen-free extract	Ether extract	Nutritive ratio, 1:
I. Pre. Oct. 25-Nov. 4	IV	137	40	40	....	....	189	252.2	71.9	166.3	16.6	33.1	104.1	5.4	9.1
Exp. Nov. 4-22	IV	263	72	72	....	....	432	491.7	129.5	328.9	32.1	67.1	204.8	10.4	9.3
II. Pre. Nov. 22-Dec. 2	O F	155	6	6	....	68	239	279.8	73.5	185.4	17.2	40.5	108.7	5.1	9.5
Exp. Dec. 2-20	O F	258	....	....	....	144	428	485.2	132.8	322.6	29.9	69.4	190.1	9.0	9.5
III. Pre. Dec. 20-30	IV	122	40	40	....	....	235	245.3	72.0	165.3	17.2	32.6	101.6	5.7	8.5
Exp. Dec. 30-Jan. 17	IV	254	72	72	....	....	411	463.9	129.7	312.5	31.7	63.7	192.4	10.2	8.8
I. Pre. Oct. 25-Nov. 4	O F	136	....	....	....	80	186	252.1	73.7	163.6	15.5	34.6	96.2	4.6	9.1
Exp. Nov. 4-22	O F	260	....	....	....	144	422	488.7	132.1	322.3	29.9	69.3	189.7	9.0	9.4
II. Pre. Nov. 22-Dec. 2	IV	141	34	34	....	12	231	263.7	72.0	178.0	17.5	36.0	111.2	5.7	9.2
Exp. Dec. 2-20	IV	259	72	72	....	....	420	480.6	129.7	324.0	31.7	65.8	202.1	10.3	9.3
III. Pre. Dec. 20 30	O F	143	....	....	....	80	227	263.0	73.6	172.1	17.2	37.5	98.6	5.2	8.7
Exp. Dec. 30-Jan. 17	O F	258	....	....	....	144	401	467.1	132.2	308.6	30.9	67.2	176.4	9.3	8.6
III. Pre. Jan. 3-15	IV	96	28	40	....	....	108	174.6	61.3	117.2	12.7	22.3	72.3	4.1	8.1
Exp. Jan. 15-Feb. 7	IV	195	69	68	....	....	236	359.3	123.4	241.0	26.6	45.9	148.6	8.6	8.2
IV. Pre. Feb. 7-19	O F	95	....	....	....	72	135	193.1	67.5	123.8	12.5	24.3	72.5	4.1	8.6
Exp. Feb. 19-Mch. 14	O F	205	....	....	....	137	354	407.3	127.3	270.0	25.9	53.1	159.6	9.2	9.0
V. Pre. Mch. 14-26	IV	165	38	37	....	....	189	211.4	67.8	144.8	14.3	25.8	93.5	5.2	9.1
Exp Mch. 26-Apl. 18	IV	207	69	69	....	....	365	409.7	124.4	280.0	27.8	52.2	174.2	10.0	9.0
VI. Pre. Apl. 18-30	O F	107	....	....	....	69	188	215.9	64 1	141.0	13.9	29.3	80.4	4.8	8.6
Exp. Apl. 30-May 23	O F	197	....	....	....	131	369	408.7	121.0	270.7	26.3	55.2	152.6	9.0	8.6
VI. Pre. Mch. 14-24	O F	173	....	....	....	80	....	223.9	74.3	149.3	13.9	30.7	77.5	4.2	8.5
Exp. Mch. 24-Apl. 11	O F	344	....	....	....	144	....	429.0	134.1	267.0	26.4	60.6	147.6	7.8	8.6
VII. Pre. Apl. 11-21	IV	193	34	34	....	12	....	240.2	72.1	151.8	15.8	33.6	90.1	4.8	8.6
Exp. Apl. 21-May 9	IV	325	72	72	....	....	....	416.3	130.0	258.7	27.4	56.7	156.7	8.5	8.6
VIII. Pre. Mar. 9-19	O F	191	10	10	....	60	....	242.3	74.1	148.7	15.0	34.9	82.2	4.2	8.7
Exp. May 19-June 6	O F	347	....	....	....	144	....	431.5	132.7	269.2	27.2	63.3	148.7	7.6	8.6
VI. Pre. Mch. 14-24	IV	151	40	40	....	....	238	270.0	72.3	182.0	17.5	35.4	114.7	6.1	9.3
Exp. Mch. 24-Apl. 11	IV	264	72	72	....	....	425	477.4	129.9	322 8	31 1	62.3	204.1	10.9	9.4
VII. Pre. Apl. 11-21	O F	150	6	6	....	68	237	276.9	74.5	183.0	17.6	39.2	101.9	5.8	8.9
Exp. Apl. 21-May 9	O F	264	....	....	....	144	432	498.0	133 3	327.7	31.5	69.8	182.7	10.5	8.5
VIII. Pre. Mar. 9-19	IV	152	30	30	....	20	240	279.5	72.2	186.8	18.4	38.1	110.3	6.4	8.9
Exp. May 19-June 6	IV	271	72	72	....	....	432	504.3	129.4	331.9	33.1	68.1	197.8	11.6	8.9

OIL FEEDING (1898) (Cottonseed oil) ACME, MINTA BELLA, RED TOP, POLLY	Nature of ration	Pounds eaten of				Total dry matter in entire ration	Total dry matter in experimental feed	*Pounds of digestible nutrients eaten during period					Nutritive ratio, 1 :
Period numbers and dates		Hay	Bran	Oil	Silage			Dry matter	Protein	Crude fiber	Nitrogen-free extract	Ether extract	
I. Pre. Jan. 25-Feb. 9	Br	182	120	....	294	345.4	....	213.6	25.1	46.2	125.2	7.9	7.6
Exp. Feb. 9-Mch. 8	Br	319	224	....	691	655.3	....	415.5	47.9	89.7	245.1	15.5	7.8
II. Pre. Mch. 8-23	Oil	166	135	8	349	367.2	....	223.7	27.0	46.6	132.5	8.6	7.4
Exp. Mch. 23-Apr. 19	Oil	304	251	36	585	682.2	....	401.3	49.0	82.9	237.7	15.3	7.3
III. Pre. Apr. 19-May 1	Br	134	108	....	252	272.7	....	174.4	21.2	36.1	103.2	6.6	7.3
Exp. May 1-24	Br	389	207	....	192	569.4	....	345.9	41.8	76.7	198.8	12.0	7.3
I. Pre. Jan. 25-Feb. 9	Br	153	120	....	232	295.0	....	186.5	23.1	38.5	110.0	7.1	7.2
Exp. Feb. 9-Mch. 8	Br	435	216	....	125	601.8	....	361.3	43.8	80.9	206.4	12.3	7.2
II. Pre. Mch. 8-23	Oil	279	120	7	...	357.7	....	206.5	24.8	47.6	116.4	6.7	7.3
Exp. Mch. 23-Apr. 19	Oil	468	208	35	...	629.0	....	349.9	42.4	80.0	197.5	11.4	7.2
III. Pre. Apr. 19-May 1	Br	232	124	....	...	312.4	....	184.4	23.5	40.1	105.1	6.2	6.8
Exp. May 1-24	Br	448	184	....	...	555.6	....	327.0	38.8	76.2	184.0	10.5	7.4
I. Pre. Jan. 25-Feb. 9	Br	...	...	....									
Exp. Feb. 9-Mch. 8	Br	317	237	....	648	641.6	....	413.0	48.8	87.6	243.9	15.6	7.5
II. Pre. Mch. 8-23	Oil	174	150	7	228	345.4	....	202.3	27.3	42.4	125.5	8.2	6.9
Exp. Mch. 23-Apr. 19	Oil	312	270	40	625	700.0	....	423.2	52.1	86.5	251.0	16.3	7.2
III. Pre. Apr. 19-May 1	Br	157	120	3	284	314.2	....	198.7	23.9	41.6	117.3	7.5	7.4
Exp. May 1-24	Br	515	230	....	180	698.1	....	420.5	49.3	96.7	239.3	14.0	7.5
I. Pre. Jan. 25-Feb. 9	Br	199	120	....	278	346.9	....	219.1	25.5	48.1	127.9	7.9	7.6
Exp. Feb. 9-Mch. 8	Br	474	216	....	145	641.3	....	385.3	45 6	88.1	219.2	12.8	7.4
II. Pre. Mch. 8 23	Oil	310	119	8	...	385.3	....	221.9	25.9	52.6	124.5	7.0	7.5
Exp. Mch. 23-Apr. 19	Oil	618	190	35	...	746.6	....	417.6	46.1	103.7	232.0	12.5	8.0
III. Pre. Apr. 19-May 1	Br	276	92	5	...	328.9	....	190.3	21.5	46.5	106.0	5.8	7.8
Exp. May 1-24	Br	527	184	....	...	625.8	....	367.7	41.9	88.9	205.3	11.3	7.7

OIL FEEDING (Cottonseed oil) EULALIE, ROSE, LALA, DIME — Periods number and dates	Nature of ration	Pounds eaten of: Hay	½ corn meal ½ bran	Emulsified oil	Silage	Total dry matter in entire ration	Total dry matter in experimental feed	Pounds of digestible nutrients eaten during period: Dry matter	Protein	Crude fiber	Nitrogen-free extract	Ether extract	Nutritive ratio, 1 :
II. Pre. Nov. 29-Dec. 9	Oil	183	80	9	229	308.1	81.1	198.8	19.3	42.6	121.5	6.0	9.2
Exp. Dec. 9-27	Oil	315	133	28	409	546.4	147.8	339.1	33.7	74.2	203.3	10.4	9.0
III. Pre. Dec. 27-Jan 11	IV	265	120	....	332	427.8	108.1	285.2	29.4	61.9	169.0	9.1	8.6
Exp. Jan. 11-Feb. 11	IV	513	216	....	626	816.4	194.5	537.5	55.1	119.1	316.5	16.9	8.6
IV. Pre. Feb. 7-19	Oil	228	96	10	279	384.5	97.1	239.7	23.7	51.3	144.7	7.5	9.0
Exp. Feb 19-Mch. 14	Oil	408	175	40	536	707.5	198.8	440.4	41.8	90.6	272.6	14.1	9.5
V. Pre. Mch. 14-26	IV	223	96	....	288	359.9	86.8	239.8	22.9	49.4	148.3	7.7	9.4
Exp. Mch. 26-Apr. 18	IV	433	184	....	552	700.8	165.9	467.3	45.1	98.6	280.1	15.1	9.2
I. Pre. Oct. 25-Nov. 6	....	....	....	....	....	....	....	....	....	....	....	....	....
Exp. Nov. 6-29	IV	218	119	....	359	406.8	107.0	272.6	26.7	55.7	169.6	8.6	9.2
II. Pre. Nov. 29-Dec. 9	Oil	101	60	9	161	198.6	63.0	128.3	12.7	25.5	80.5	4.1	9.1
Exp. Dec. 9-27	Oil	140	61	28	222	271.8	82.9	160.8	15.8	35.0	96.8	5.1	9.1
III. Pre. Dec. 27-Jan. 11	IV	139	86	....	194	250.6	77.5	169.3	17.8	33.7	103.3	5.8	8.5
Exp. Jan. 11-Feb. 7	IV	287	162	....	335	489.6	145.9	325.3	34.3	66.5	196.3	11.0	8.4
IV. Pre. Feb. 7-19	Oil	131	72	10	120	227.8	75.4	140.5	14.4	27.9	86.5	4.7	8.7
Exp. Feb. 19-Mch. 14	Oil	227	106	40	252	406.4	136.2	240.7	23.3	48.5	149.9	7.8	9.3
V. Pre. Mch. 14-26	IV	123	71	....	133	207.6	64.2	138.8	13.7	26.2	88.0	4.7	9.2
Exp. Mch. 25-Apr. 18	IV	253	138	....	269	421.4	124.5	281.5	28.0	55.5	172.8	9.6	9.0
II. Pre. Nov. 29-Dec. 9	Oil	99	80	9	229	235.2	81.1	156.3	15.5	29.2	100.4	5.2	9.2
Exp. Dec. 9-27	Oil	164	124	28	343	385.2	139.7	241.9	24.6	45.8	152.6	8.4	8.9
III. Pre. Dec. 27-Jan. 11	IV	153	120	....	273	314.8	108.1	216.0	22.9	40.1	134.7	7.7	8.5
Exp. Jan. 11-Feb. 7	IV	321	216	....	502	614.4	194.5	414.2	43.7	80.6	254.6	14.4	8.4
IV. Pre. Feb. 7-19	Oil	180	96	10	214	222.0	97.1	201.6	20.4	40.5	124.1	6.7	8.8
Exp. Feb. 19-Mch. 14	Oil	333	169	40	436	608.2	193.4	376.8	36.4	74.2	236.5	12.5	9.3
III. Pre. Jan. 11-21	....	....	....	....	....	....	....	....	....	....	....	4.8	....
Exp. Jan. 11-Feb. 7	IV	265	221	....	431	548.8	199.1	374.2	40.2	67.9	234.5	13.8	8.3
IV. Pre. Feb. 7-19	Oil	110	96	10	191	253.5	97.1	161.3	16.8	27.9	103.9	5.9	8.7
Exp. Feb. 19-Mch. 14	Oil	185	181	40	397	479.4	204.3	302.0	30.4	48.7	200.1	11.3	9.1
V. Pre. Mch. 14-26	IV	111	96	....	236	248.8	86.8	172.1	17.2	29.0	112.8	6.3	9.1
Exp. Mch. 26-Apr. 18	IV	217	179	....	457	482.3	161.4	333.4	33.4	58.6	211.0	12.3	8 9

OIL FEEDING (Corn oil) / EDNA, ANNIE, CERES / Period numbers and dates	Nature of ration	Pounds eaten of: Hay	½ corn meal ½ bran	Emulsified oil	Silage	Total dry matter in entire ration	Total dry matter in experimental feed	Pounds of digestible nutrients eaten during period: Dry matter	Protein	Crude fiber	Nitrogen-free extract	Ether extract	Nutritive ratio, 1:
I. Pre. Oct. 25-Nov. 6	IV	163	96	....	222	299.9	86.3	197.8	19.8	39.1	123.8	6.4	9.0
Exp. Nov. 6-29	IV	346	184	....	525	627.9	165.5	419.1	41.1	85.9	260.2	13.2	9.2
II. Pre. Nov. 29-Dec. 9	Oil	141	80	9	234	273.1	81.1	178.7	17.5	36.2	111.6	5.6	9.2
Exp. Dec. 9-27	Oil	244	121	28	388	466.6	137.0	290.4	28.9	61.2	176.8	9.3	9.0
III. Pre. Dec. 27-Jan. 11	IV	209	120	....	222	349.3	108.1	233.7	24.9	47.4	141.2	7.9	8.3
Exp. Jan. 11-Feb. 7	IV	407	215	....	612	719.3	193.6	480.3	49.6	100.4	288.9	15.8	8.6
IV. Feb. 7-19	Oil	179	96	12	267	339.6	99.1	212.5	21.3	42.7	131.1	7.1	9.0
Exp. Feb. 19-Mch. 14	Oil	326	170	40	525	628.7	194.3	393.4	37.7	76.9	247.8	13.1	9.4
V. Pre. Mch. 17-26	IV	179	92	....	280	315.9	83.1	213.3	20.5	41.9	134.1	7.1	9.4
Exp. Mch. 26-Apr. 18	IV	343	184	....	532	617.4	165.9	417.4	40.9	82.8	255.0	14.3	9.1
II. Pre. Nov. 29-Dec. 9	Oil	109	80	9	182	229.8	81.1	150.6	15.2	28.3	96.0	5.0	9.0
Exp. Dec. 9-27	Oil	161	130	28	268	366.0	145.1	228.0	23.9	41.5	144.6	8.0	8.6
III. Pre. Dec. 27-Jan. 11	IV	185	120	....	202	323.0	108.1	217.3	14.3	42.4	132.8	7.5	8.3
Exp. Jan. 11-Feb. 7	IV	410	216	....	478	685.3	194.5	454.2	47.7	94.7	272.5	15.1	8.5
IV. Pre. Feb. 7-19	Oil	165	96	12	166	295.8	99.1	183.8	18.9	35.9	113.8	6.2	8.7
Exp. Feb. 19-Mch. 14	Oil	327	171	40	336	576.0	195.2	353.2	34.7	68.9	221.9	11.5	9.2
V. Pre. Mch. 17-26	IV	174	96	....	174	285.6	86.8	190.3	18.8	36.6	120.0	6.3	9.1
Exp. Mch. 26-Apr. 18	IV	348	184	....	336	564.3	165.9	375.6	37.6	74.7	230.1	12.7	8.9
I. Pre. Oct. 25-Nov. 6	IV	96	96	....	237	247.0	86.3	167.4	17.0	29.2	109.2	5.9	9.0
Exp. Nov. 6-29	IV	237	184	....	546	538.2	165.5	368.7	36.5	69.6	235.8	12.3	9.2
II. Pre. Dec. 27-Jan. 11	Oil	104	80	9	233	240.7	81.1	159.7	15.8	30.2	102.2	5.3	9.2
Exp. Dec. 9-27	Oil	175	109	28	347	382.6	126.2	238.3	23.9	47.7	148.0	7.9	9.0
III. Pre. Dec. 27-Jan. 11	IV	149	120	....	282	313.9	108.1	215.9	22.8	39.8	135.0	7.8	8.5
Exp. Jan. 11-Feb. 7	IV	297	216	....	517	597.7	194.5	405.1	42.7	77.2	250.9	14.3	8.5
IV. Pre. Feb. 7-19	Oil	129	96	10	233	283.4	97.1	180.0	18.3	32.8	114.2	6.4	8.9
Exp. Feb. 19-Mch. 14	Oil	217	144	40	413	478.2	170.7	296.6	28.8	54.2	190.6	10.4	9.4

OIL FEEDING (Linseed oil) ROWENA, RED TOP, MARJORY — Period numbers and dates	Nature of ration	Pounds eaten of: Hay	½ corn meal ½ bran	Emulsified oil	Silage	Total dry matter in entire ration	Total dry matter in experimental feed	Pounds of digestible nutrients eaten during period: Dry matter	Protein	Crude fiber	Nitrogen-free extract	Ether extract	Nutritive ratio, 1 :
I. Pre. Oct. 26-Nov. 6	IV	166	96	....	234	306.4	86.3	202.1	20.1	40.3	126.3	6.4	9.0
Exp. Nov. 6-29	IV	340	184	....	548	629.5	165.5	421.2	41.2	86.2	262.0	13.3	9.2
II. Pre. Nov. 29-Dec. 9	Oil	129	80	9	240	264.5	81.1	174.0	17.0	34.6	109.5	5.6	9.3
Exp. Dec. 9-27	Oil	210	118	28	353	423.4	134.3	263.4	26.5	53 9	162.0	8.6	9.0
III. Pre. Dec. 27-Jan. 11	IV	195	120	....	317	363.2	108.1	246.6	25.7	49.3	150.5	8.4	8.6
Exp. Jan. 11-Feb. 7	IV	384	216	....	446	653.7	194.5	434.3	45.9	88.8	262.1	14.5	8.4
IV. Pre. Feb. 7-19	Oil	177	96	10	180	308.7	97.1	192.8	19.7	38.5	118.7	6.4	8.8
Exp. Feb. 19-Mch. 14	Oil	326	183	40	358	692.3	206.1	365.5	36.0	69.9	231.2	12.3	9.2
I. Pre. Oct. 26-Nov. 6	IV	184	96	....	234	321.9	86.3	211.2	20.9	43.2	130.8	6.6	9.0
Exp. Nov. 6-29	IV	338	184	....	541	625.6	165.5	418.6	41.0	85.4	260.5	13.2	9.2
II. Pre. Nov. 29-Dec. 9	Oil	149	80	9	227	278.0	81.1	181.2	17.7	37.1	112.6	5.7	9.3
Exp. Dec. 9-27	Oil	240	104	28	373	443.3	121.7	273.6	26.9	59.6	164.8	8.6	8.8
III. Pre. Dec. 27-Jan. 11	IV	208	120	....	340	380.6	108.1	258.0	26.7	52.6	156.6	8.6	8.6
Exp. Jan. 11-Feb. 7	IV	405	216	....	617	719.7	194.5	480.9	49.7	100.2	289.8	15.9	8.6
IV. Pre. Feb. 7-19	Oil	177	96	10	273	338.0	97.1	212.7	21.3	42.6	131.4	7.1	9 0
Exp. Feb. 19-Mch. 14	Oil	336	179	40	542	650.4	202.5	408.2	39.2	79.3	257.5	13.7	9.4
I. Pre. Oct. 26-Nov. 6	IV	167	96	....	234	307.2	86.3	202.6	20.2	40.5	126.5	6.5	9.0
Exp. Nov. 6-29	IV	335	184	....	538	622.1	165.5	416.4	40.8	84.9	259.2	13.2	9.2
II. Pre. Nov. 29-Dec. 9	Oil	147	80	9	239	279.8	81.1	182.9	17.8	37.4	113.9	5.8	9.3
Exp. Dec. 9-27	Oil	241	118	28	393	462.6	134.3	288.4	28.6	61.0	175.2	9.2	9.1
III. Pre. Dec. 27-Jan. 11	IV	207	120	....	347	381.7	108.1	258.9	26.8	52.7	157.3	8.7	8.6
Exp. Jan. 11-Feb. 7	IV	406	216	....	626	723.1	194.5	483.4	49.9	100.8	291.2	15.9	8.6
IV. Pre. Feb. 7-19	Oil	176	96	10	272	336.8	97.1	212.0	21.2	42.4	131.1	7.1	9.0
Exp. Feb. 19-Mch. 14	Oil	319	163	40	522	615.3	187.9	384.5	36.8	75.6	241.9	12.8	9.5
V. Pre. Mch. 14-26	IV	172	95	....	279	312.4	85.8	212.2	20.5	40.7	134.3	7.1	9.4
Exp. Mch. 25-Apr. 18	IV	338	184	....	527	611.6	165.9	413.7	40.5	81.8	253.2	14.1	9.1

MEDIUM AND WIDE RATIOS BETTIE, FAIRIE, MINTA BELLA, FLORA, DANDELION Period numbers and dates	Nature of ration	Pounds eaten of: Hay	Corn	Bran	½ cottonseed ½ linseed	Quaker Oat feed	Silage	Total dry matter in entire ration	Total dry matter in experimental feed.	Pounds of digestible nutrients eaten during period: Dry matter	Protein	Crude fiber	Nitrogen-free extract	Ether extract	Nutritive ratio, 1:
I. Pre. Oct. 25-Nov. 4	I	147	20	30	30	...	187	261 0	72.8	171.3	24.3	35.3	96.8	6.1	6.1
Exp. Nov. 4-22	I	343	36	54	54	...	430	563.5	131.5	369.7	48.9	81.1	207.5	12.2	6.5
II. Pre. Nov. 22-Dec. 2	O F	188	2	5	5	68	238	308.5	73.5	201.9	18.7	45.9	116.9	5.4	9.5
Exp. Dec. 2-20	O F	338	...	...	...	144	432	556.4	132.8	364.1	33.6	82.4	210.8	9.8	9.5
III. Pre. Dec. 20-30	I	182	20	30	30	...	240	299.9	72.7	197.0	28.1	43.7	96 0	7.1	5.6
Exp. Dec. 30. Jan. 17	I	330	36	54	54	...	420	533.7	131.2	353.2	50.4	78.6	189.9	12.7	6.0
I. Pre. Oct. 15-Nov. 4	O F	127	...	...	...	80	182	243 1	73.7	158.2	15.0	32.9	93.4	4.5	9.2
Exp. Nov. 4-22	O F	256	...	...	...	144	412	482.1	132.1	318.0	29.6	68.2	187.3	8.9	9.5
II. Pre. Nov. 22-Dec. 2	I	134	16	26	26	12	233	259.0	72.8	175.3	24 5	35.7	100.2	6.3	6.2
Exp. Dec. 2-20	I	234	36	54	54	...	406	455.6	130.8	309.0	43.6	62.3	176.6	11.1	6.1
III. Pre. Dec. 20-30	O F	119	...	...	...	80	222	240.6	73.6	159.1	15.9	33.1	92.1	5.0	8.6
Exp. Dec. 30 Jan. 17	O F	240	...	...	...	144	383	446.5	132.2	295.7	29.7	63.3	169.7	9.0	8.6
III. Pre. Jan. 3-15	II	102	15	37	32	...	274	241.5	76.6	165.0	26.8	32.1	89.7	6.8	5.2
Exp. Jan. 15-Feb. 7	II	219	23	69	69	...	545	489.7	146.6	332.2	52.9	66.3	180.2	13.3	5.3
IV. Pre. Feb. 7-19	O F	112	...	...	...	96	282	276.8	90.0	179.6	17.7	34.4	106.9	6.2	8.8
Exp. Feb. 19-Mch. 14	O F	202	...	...	...	184	550	504.9	171.0	342.0	33.0	62.7	206.4	12.4	9 1
V. Pre. Mch. 14-26	I	110	24	36	36	...	288	263.2	87.5	183.4	27.3	32.1	107.5	8.0	5.8
Exp. Mch. 26-Apr. 18	I	208	46	69	69	...	547	506.5	167.0	353.1	54.8	62 6	197.3	15.3	5.4
VI. Pre. Apr. 18-30	O F	108	...	...	...	94	283	269.0	87.2	181.5	17.7	34.8	103.6	6.3	8.7
Exp. Apr. 30-May 23	O F	189	...	...	...	177	546	499.5	163 5	337.7	32.9	63.6	193.1	11.8	8.7
V. Pre. Feb. 14-24	I	131	22	31	27	...	223	255.9	73.2	168.9	24.1	32.3	96.	6.9	6.0
Exp. Feb. 24-Mch. 14	I	251	36	54	54	...	430	476.2	131.7	319.5	44.8	62.5	181.1	12.6	6.1
VI. Pre. Mch. 14-24	O F	142	...	...	...	80	240	264.8	74.3	176.2	16.6	36.0	103.1	5.8	9.2
Exp. Mch. 24-Apr. 11	O F	254	...	...	...	144	432	475.1	134.1	316.3	29.9	64.6	186.0	10.5	9.2
VII. Pre. Apr. 11-21	I	150	16	26	26	12	240	276.0	72.7	186.0	27.7	38.1	98.5	7.1	5.6
Exp. Apr. 21-May 9	I	251	36	54	54	...	432	484.1	130.9	325.2	49.1	65.5	172.6	12.7	5.5
VI. Pre. Mch. 14-24	I	216	20	30	30	...	...	259.7	72.9	162 9	24.0	36.5	86.1	5.6	5.8
Exp. Mch. 24-Apr. 11	I	415	36	54	54	...	...	487.1	131.3	306.3	44.3	69.9	161.6	10.6	6.1
VII. Pre. Apr. 11-21	O F	231	3	5	4	68	...	275.7	74.5	168.9	16.9	41.7	92.0	4.6	8.7
Exp. Apr. 21-May 9	O F	400	...	...	...	144	...	485.7	133.3	296.0	29.6	72.3	161.7	8.1	8.7
VIII. Pre. May-9-19	I	228	14	21	21	24	...	273.5	72.7	169.7	26.8	39.9	87.4	5.9	5.4
Exp. May 19-June 6	I	408	36	54	54	...	...	481.8	130.5	304.1	48.1	71.4	156.8	10.5	5.4

MEDIUM AND WIDE-SCANT RATIOS POLELA, PAULINE, INEZ, PRISCILLA, SYLVIA Period numbers and dates	Nature of ration	Pounds eaten of: Hay	⅔ corn meal ⅓ bran	Buffalo gluten feed	Silage	Beets	Total dry matter in entire ration	Total dry matter in experimental feed	Pounds of digestible nutrients eaten during period: Dry matter	Protein	Crude fiber	Nitrogen-free extract	Ether extract	Nutritive ratio, 1 :
IV. Pre. Feb. 7-19	V	181	36	...	252	...	270.6	32.8	171.2	15.5	44.5	99.6	4.6	10.0
Exp. Feb. 19-Mch. 14	V	347	69	...	551	...	523.3	63.2	344.7	29.8	80.1	205.6	9.9	10.3
V. Pre. Mch. 14-27	B G	185	...	96	288	...	329.1	88.8	230.2	33.6	47.0	132.0	6.1	5.8
Exp. Mch. 27-Apr. 18	B G	359	...	184	551	...	641.0	170.2	448.2	65.3	93.2	249.1	11.9	5.7
VI. Pre. Apr. 18-30	V	187	36	...	288	...	285.3	32.5	187.4	16.8	45.7	103.0	5.4	9.6
Exp. Apr. 30-May 23	V	349	69	...	552	...	540.2	62.3	354.5	31.6	86.0	195.1	10.2	9.6
III. Pre. Jan. 3-15	B G	177	8	86	...	240	293.4	86.3	215.9	31.2	38.0	127.1	3.9	5.7
Exp. Jan. 15-Feb. 7	B G	350	...	184	...	459	582.1	168.9	422 1	61.2	74.6	247.9	7.8	5.7
IV. Pre. Feb. 7-19	V	183	36	...	...	240	250.7	32.8	171.7	14 0	34.1	105.1	3.1	10.5
Exp. Feb. 19-Mch. 14	V	344	68	4	...	460	468.1	65.9	326.8	25.7	62.7	201.8	5.9	10.8
V. Pre. Mch. 14-27	B G	182	...	96	...	240	299.2	88.8	209.9	31.1	37.2	123.4	3.9	5.6
Exp. Mch. 27-Apr. 18	B G	350	...	184	...	450	552.5	170.2	402.1	60.1	72.5	234.7	7.5	5.4
I. Pre. Oct. 25-Nov. 6	V	204	36	...	105	...	242.8	32.4	152.3	13.8	38.7	87.2	4.0	9.8
Exp. Nov. 6-29	V	539	68	4	...	...	539.0	64.7	324.5	30.2	87.0	176.7	7.7	9.3
II. Pre. Nov. 29-Dec. 11	B G	254	...	96	...	...	308 4	87.9	202.6	32.2	45.1	108.8	4.6	5.1
Exp. Dec. 11-Jan. 3	B G	509	...	184	...	...	616.3	168.9	399 8	64.0	95.4	207.1	8 8	5.1
III. Pre. Jan. 3-15	V	268	33	12	...	...	272.5	40.4	168.0	16.8	46.2	89.4	4.0	8.6
Exp. Jan. 15-Feb. 7	V	533	69	...	...	...	526.5	62.0	319.5	31.8	91.6	166.0	7.1	8.6
IV. Pre. Feb. 7-19	B G	281	...	91	...	...	330.2	84.3	215.9	33.7	51.1	113 6	4.6	5.2
Exp. Feb. 19-Mch. 14	B G	527	...	180	...	...	624 3	166.6	406.9	61.7	93.5	219.2	8.8	5.4
V. Pre. Mch. 14-27	V	252	36	...	...	...	250.1	32.9	152.0	13.6	41.0	84.5	3.5	9.8
Exp. Mch. 27-Apr. 18	V	538	69	...	...	...	526.7	62.8	320.9	29.3	89.5	174.0	7.2	9.5
VI. Pre. Apr. 18-30	B G	272	...	89	...	...	320.9	81.7	206.9	31.4	50.2	108.8	4.5	5.4
Exp. Apr. 30-May 23	B G	491	...	151	...	...	567.9	138.4	366.0	54.7	90.1	191.8	8.0	5.5
II. Pre. Nov. 29-Dec. 11	V	185	36	...	...	240	246 8	32.4	173.3	13.9	33.3	108.2	3.2	10.7
Exp. Nov. 6-29	V	359	69	...	...	460	480.3	61.9	334.4	28.3	73.8	203.4	5.9	10.4
III. Pre. Jan. 3-15	B G	179	3	88	...	240	293.3	83.6	214.7	30.7	38.2	126.2	3.9	5.7
Exp. Jan. 15-Feb. 7	B G	325	...	184	...	457	559.9	168.9	409.0	60.0	70.4	241.5	7.5	5.6
IV. Pre. Feb. 7-19	V	178	36	...	...	238	245.9	32.8	168.7	13.8	32.7	103.6	3.0	10.5
Exp. Feb. 19-Mch. 14	V	339	69	...	...	457	460.3	63.2	321.4	25.3	61.7	198.3	5.7	10.8
V. Pre. Mch. 14-27	B G	180	...	96	...	238	297.1	88.8	208.5	31.0	36.8	122.6	3.9	5.5
Exp Mch. 27-Apr. 18	B G	347	...	181	...	447	546.6	167.5	397.7	59.2	71.7	232.1	7.4	5.5
I. Pre. Oct. 25-Nov. 6	V	200	36	...	105	...	239.4	32.4	150 3	13.6	38.0	86.2	4.0	9.7
Exp. Nov. 6-29	V	549	69	4	...	...	548.6	65.5	330.4	30.7	88.5	180.5	7.9	9.4
II. Pre. Nov. 29-Dec. 11	B G	264	...	96	...	...	317.2	87.9	207.7	32.6	46.7	111.3	4.7	5.2
Exp. Dec. 11-Jan. 3	B G	471	...	179	...	...	578.3	164.3	376.6	61.1	88.7	195.7	8.4	5.0
III. Pre. Jan. 3-15	V	266	33	8	...	...	267.2	36.8	164.2	16.4	45.8	86.7	3.8	8.6
Exp. Jan. 15-Feb. 7	V	518	69	...	...	...	513.4	62.0	312.0	31.1	89.0	162.5	7.0	8.6
IV. Pre. Feb. 7-19	B G	258	...	85	...	...	304.5	78.7	195.9	30.1	47.1	102.7	4.2	5.4
Exp. Feb. 19-Mch. 14	B G	500	...	157	...	...	579.7	145.4	377.9	55.1	88.6	199.1	7.9	5.6
V. Pre. Mch. 14-27	V	279	34	...	...	...	271.5	31.1	164.7	14.7	45.3	90.1	3.6	9.8
Exp. Mch. 27-Apr. 18	V	542	69	...	...	...	530.1	62.8	322.9	29.5	90.2	175.0	7.3	9.5
VI. Pre. Apr. 18-30	B G	263	...	94	...	...	317.6	86 3	206.3	32.1	48 9	108.9	4.5	5.4
Exp. Apr. 30-May 23	B G	513	...	173	...	...	607.2	158.5	394.4	60.4	94.9	207.5	8.7	5.5

BUCKWHEAT MIDDLINGS / ADAH, MAIZIE, SALIDA, NAOMI, MAXELLA, ORPHA / Period numbers and dates	Nature of ration	Pounds eaten of: Hay	Corn meal	Bran	½ cottonseed meal ½ linseed meal	Buckwheat middlings	Silage	Total dry matter in entire ration	Total dry matter in experimental feed	Pounds of digestible nutrients eaten during period: Dry matter	Protein	Crude fiber	Nitrogen-free extract	Ether extract	Nutritive ratio, 1:
III. Pre. Jan. 3-15	II	81	11	35	34	...	163	228 4	72.9	128.2	23.2	23.2	68.7	5.7	4.6
Exp. Jan. 15-Feb. 7.	II	184	23	69	69	...	425	425.7	146.6	289.3	49.2	54.7	156.1	12.2	4.9
IV. Pre. Feb. 7-19	III	101	12	36	....	48	180	232.2	87.1	...	...	...	...	...	...
Exp. Feb. 19-Mch. 14	III	200	23	69	....	92	354	442.7	167.0	...	...	...	...	...	...
V. Pre. Mch. 14-26	II	103	12	36	36	...	187	217.9	76.6	148.3	24.9	26.5	82.1	6.6	5.0
Exp. Mch. 26-Apr. 18	II	191	22	66	65	...	338	402.5	138.9	273.8	47.1	50.1	146.9	11.8	4.8
VI. Pre. Apr. 18-30	III	105	12	35	....	48	188	234.7	84.7	...	...	...	...	...	...
Exp. Apr. 30-May 23	III	177	20	61	....	84	163	417.0	148.7	...	...	...	...	...	...
III. Pre. Jan. 3-15	I	233	24	36	36	...	...	289.3	87.5	183.0	29.7	41.8	92.5	6.7	5.1
Exp. Jan. 15-Feb. 7	I	444	46	69	69	...	...	554.6	167.7	349.5	56.6	79.6	176.6	12.9	5.1
IV. Pre. Feb. 7-19	III	228	12	36	....	48	...	286.6	87.1	...	...	...	...	...	...
Exp. Feb 19-Mch. 14	III	424	23	69	....	92	...	535.3	167.0	...	...	...	...	...	...
V. Pre. Mch. 14-26	I	233	21	32	31	...	...	277.4	76.6	174.1	25.4	39.3	91.9	6.1	5.7
Exp. Mch. 26-Apr. 18	I	451	40	61	60	...	...	533.9	145.1	336.7	51.2	77.5	175.7	11.8	5.5
VI. Pre. Apr. 18-30	III	266	12	36	....	48	...	320.4	86.5	...	...	...	...	...	...
Exp. Apr. 30-May 23	III	485	23	69	....	92	...	590.1	165.8	...	...	...	...	...	...
VI. Pre. Mch. 14-24	I	152	17	27	26	...	160	240.4	63.8	158.9	22.1	32.8	88.6	6.1	6.1
Exp. Mch. 24-Apr. 11	I	270	31	48	47	...	288	428.5	114.9	284.2	39.8	58.6	158.5	10.8	6.0
VII. Pre. Apr. 11-21	III	150	12	29	4	34	160	250.4	71.3	...	...	...	...	...	...
Exp. Apr. 21-May 9	III	252	18	54	....	72	286	439.0	129.6	...	...	...	...	...	...
VIII. Pre. May 9-19	I	150	18	31	22	9	160	253.7	72.7	167.4	26.2	34.3	88.4	6.4	5.2
Exp. May 19-June 6	I	264	36	54	54	...	288	452.2	130.5	298.3	37.0	60.7	157.7	11.7	5.2
V. Pre. Feb. 14-24	I	146	23	32	25	...	159	249.4	73.2	162.5	23.7	32.0	90.9	6.5	5.8
Exp. Feb. 24-Mch. 14	I	265	36	55	52	1	300	448.3	131.7	296.5	43.1	58.6	166.2	11.7	5.9
VI. Pre. Mch. 14-24	III	152	10	30	....	39	200	259.5	71.6	...	...	...	...	...	...
Exp. Mch. 24-Apr. 11	III	275	18	53	....	69	360	464.8	126.4	...	...	...	...	...	...
VII. Pre. Apr. 11-21	I	153	19	29	25	6	200	265.6	71.8	178.2	27.0	36.7	94.2	6.9	5.5
Exp. Apr. 21-May 9	I	272	36	54	54	...	322	468.9	130.9	309.3	47.2	61.5	165.4	11 9	5.4
II. Pre. Nov. 22-Dec. 2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Exp. Dec. 2-20	IV	262	72	72	....	....	357	464.4	129.7	311.1	30.8	62.8	193.7	9.9	9.1
III. Pre. Dec. 20-30	III	143	10	30	....	40	200	253.9	72.1	...	...	...	...	...	...
Exp. Dec. 30-Jan. 17	III	258	18	54	....	72	360	453.4	129.9	...	...	...	...	...	...
IV. Pre. Jan. 17-27	IV	148	40	40	....	....	200	256.7	72.0	171.1	17.9	35.5	103.0	5.7	8.5
Exp. Jan. 27-Feb. 14	IV	268	72	72	....	....	360	462.1	129.7	308.8	32.2	64.1	185.8	10.3	8.5
V. Pre. Feb. 14-24	III	150	13	31	....	36	170	248.4	65 4	...	...	...	...	...	...
Exp. Feb. 24-Mch. 14	III	262	18	54	....	72	357	461.0	130.7	...	...	...	...	...	...
VI. Pre. Mch. 14-24	IV	142	40	40	....	....	200	251.5	72.3	169.2	16.4	32.3	107.0	5.7	9.2
Exp. Mch. 24-Apr. 11	IV	278	72	72	....	....	360	470.9	129.9	315.6	30.5	61.7	198.4	10.5	9.3
VI. Pre. Mch. 14-24	IV	145	40	40	....	....	....	197.7	72.3	126.7	13.1	31.9	79.3	4.1	9.2
Exp. Mch. 24-Apr. 11	IV	312	72	72	....	....	....	397.4	129.9	252.2	27.2	67.3	157.5	8.5	9.0
VII. Pre. Apr. 11-21	B M	197	6	6	....	68	...	243.6	72.1	...	...	...	...	...	...
Exp. Apr. 21-May 9	B M	338	....	....	....	139	...	422.8	125.2	...	...	...	...	...	...
VIII. Pre. May 9-19	IV	192	30	30	....	20	...	241.3	72.0	152.2	...	...	...	...	...
Exp. May 19-June 6	IV	341	72	72	....	....	....	423.0	129.4	267.8	28.8	71.4	167.0	9.0	9.1
SILAGE VS. ARTICHOKES / LADY PERUSIA															
I. Pre. Oct. 25-Nov. 4	Si	108	26	26	....	180	...	199.6	59.2	130.8	12.+	27.6	80.8	4.0	9.4
Exp. Nov. 4-22	Si	185	72	72	....	428	...	423.8	129.6	288.5	28.5	54.4	184.7	9.7	9.2
II. Pre. Nov. 22-Dec. 7	Art	168	60	60	....	60	227	318.1	45.5	222.8	23.8	33.1	150.3	6.3	8.4
Exp. Dec. 7-Jan. 3	Art	324	108	108	....	....	499	587.8	106.7	410.6	45.0	62.0	271.3	11.7	8.1
III. Pre. Jan. 3-18	Si	179	60	60	....	119	180	337.4	33.3	234.5	25.2	39 1	151.4	7.1	8.3
Exp. Jan. 18-Feb. 14	Si	296	108	108	....	643	...	634.5	179.7	233.2	43.6	80.2	274.5	15.4	9.0

WATERING AT WILL AND AT INTERVALS HAZEL, LILAC, CLARE, PUSSY WILLOW Period numbers and dates	Manner of watering	Pounds eaten of: Hay	Silage	Total dry matter in entire ration	Total dry matter in experimental feed (grain)	Pounds of digestible nutrients eaten during period: Dry matter	Protein	Crude fiber	Nitrogen-free extract	Ether extract	Nutritive ratio, 1 :
IV. Pre. Jan. 17-27	yard	89	154	183.6	63.1	124.7	13.4	23.2	87.8	4.5	9.1
Exp. Jan. 27-Feb. 14	yard	161	272	328.3	113.5	223.8	23.9	41.6	139.5	8.1	9.0
V. Pre. Feb. 14-24	will	89	153	188.2	63.6	125.4	12.5	21.7	81.7	4.5	9.0
Exp. Feb. 24-Mch. 14	will	158	286	333.9	114.3	227.0	22.6	39.1	148.1	8.2	9.0
VI. Pre. Mch. 14-24	yard	86	159	179.0	59.7	122.5	12.1	21.4	79.7	4.4	9.1
Exp. Mch. 24-Apr. 11	yard	162	271	324.4	108.2	221.6	22.0	38.5	143.7	7.9	9.1
VII. Pre. Apr. 11-21	will	94	157	197.9	68.5	135.5	13.9	24.2	83.4	5.1	8.6
Exp. Apr. 21-May 9	will	166	285	363.3	130.0	247.7	25.6	43.3	153.5	9 4	8.6
IV. Pre. Jan. 17-27											
Exp. Jan. 27-Feb. 14	yard	172	270	351.9	127.9	259.8	25.8	43.6	170.2	8.8	9 0
V. Pre. Feb. 14-24	will	89	151	196.7	72.7	131 6	13.3	21.7	86.8	4.9	9.0
Exp. Feb. 24-Mch. 14	will	165	276	353.4	130.6	240.4	24.3	40.0	158.1	8.9	9.0
VI. Pre. Mch. 14-24	yard	92	155	195.6	72.3	134.0	13.5	22.3	88.2	4.9	9.0
Exp. Mch. 24-Apr. 11	yard	172	281	356.5	129.0	244 3	24 6	41.3	160.1	8.9	9.0
VII. Pre. Apr. 11-21	will	95	159	202.1	71.2	138.5	14.2	24.5	85.5	5.2	8.5
Exp. Apr. 21-May 9	will	169	284	365.7	130.0	249.0	25.7	43.8	154.1	9 4	8.5
V. Pre. Feb. 14-24	will	157	239	283.0	72.7	185.1	17.8	36.4	116.4	6.2	9.3
Exp. Feb. 24-Mch. 14	will	276	430	494.2	130.6	329.7	31.7	64.5	207.8	11.0	9.5
VI. Pre. Mch. 14-24	yard	156	240	374.9	72.3	184.8	17.8	36.3	116 3	6.2	9.4
Exp. Mch. 24-Apr. 11	yard	283	432	495.7	129.9	324.0	32.0	65.7	209 8	11.1	9.3
VII. Pre. Apr. 11-21	will	157	240	281.5	72.1	189.3	18.7	38.9	111.5	6.5	8.8
Exp. Apr. 21-May 9	will	279	432	507.8	130.0	339.0	33.4	69.4	159.8	11.6	8.8
IV. Pre. Jan. 17-27											
Exp. Jan. 27-Feb. 14	yard	295	307	467.8	126.1	308.6	32.3	66.3	183.1	10.0	8.5
V. Pre. Feb. 14-24	will	152	139	247.9	72.7	160.7	15.8	31.3	100.9	5.3	9.1
Exp. Feb. 24-Mch. 14	will	266	287	444.3	130.6	293.6	28.7	56.7	185.1	9 8	9.1
VI. Pre. Mch. 14-24	yard	148	168	244.9	72.3	162 9	16.0	31.5	102.6	5.4	9.2
Exp. Mch. 24-Apr. 11	yard	273	286	443.6	128.0	295.6	28.9	57.8	185.6	9.8	9.2
VII. Pre. Apr. 11-21	will	153	160	253.8	72.1	168.7	17.0	34.4	100.4	5.8	8.7
Exp. Apr. 21-May 9	will	244	278	429.8	130.9	285.6	29.0	56.1	171.8	10.1	8.7

Pounds eaten of: ½ corn meal – ½ bran

GROOMING AND NO GROOMING LEAH, POLLY, POMONA, LADY PERUSIA, BONNIE BELLE Period numbers and dates	Groomed or not groomed	Pounds eaten of					Total dry matter in entire ration	Total dry matter in experimental feed (grain)	Pounds of digestible nutrients eaten during period					Nutritive ratio, 1:
		Hay	Corn meal	Bran	½ cottonseed & linseed	Silage			Dry matter	Protein	Crude fiber	Nitrogen-free extract	Ether extract	
V. Pre. Feb. 14-24	not gr	83	22	31	27	155	193.1	73.2	129.9	21.0	21 6	74.6	5.9	5.3
Exp. Feb. 24-Mch. 14	not gr	157	36	54	54	277	347.9	131.7	237.2	38.1	40.2	135.8	10.6	5.3
VI. Pre. Mch. 14-24	gr	91	18	27	27	158	189.0	65.7	129.1	19.8	23.0	73.8	5.7	5.6
Exp. Mch. 24-Apr. 11	gr	168	35	52	53	283	352.4	127.7	241.2	37.8	42.1	137.8	10.6	5.4
VII. Pre. Apr. 11-21	not gr	95	19	28	28	159	199.9	68.2	136.5	22.8	25.1	73.0	5.8	5.0
Exp. Apr. 21-May 9	not gr	171	35	53	53	282	365.0	128.2	247.7	42.0	44.6	132.8	10.5	4.9
V. Pre. Feb. 14-24	gr	151	22	31	27	154	252.1	73.2	163.9	23.7	32.6	91.5	6.5	5.9
Exp. Feb. 24-Mch. 14	gr	247	36	54	54	288	429.2	131.7	284.8	42.1	55.2	159.3	11.5	5.8
VI. Pre. Mch. 14-24	not gr	145	20	30	30	200	254 7	72.9	171.0	24.3	33.6	96.5	6.8	6.0
Exp. Mch. 24-Apr. 11	not gr	277	36	54	54	388	479.4	131.3	321.8	45.1	64.3	181.6	12.5	6.1
VII. Pre. Apr. 11-21	gr	152	20	30	30	200	265.6	72.7	177.7	27.0	36.5	94.0	6.9	5.5
Exp. Apr. 21-May 9	gr	257	36	54	54	360	467.3	130.9	311.4	47.9	62.9	165 0	12.2	5.4
V. Pre. Feb. 14-24	not gr	148	22	31	27	151	248.6	73.2	161.7	23.7	32.0	90.3	6.4	5.8
Exp. Feb. 24-Mch. 14	not gr	254	36	54	54	286	434.7	131.7	288.0	42.3	56.3	161.5	11.5	5.8
VI. Pre. Mch. 14-24	gr	149	20	30	30	160	246.9	72.9	164.2	23.8	32.5	91.9	6.5	5.9
Exp. Mch. 24-Apr. 11	gr	276	36	53	53	286	447.6	129.5	299.0	43.3	59.8	167.0	11.7	5.8
VII. Pre. Apr. 11-21	not gr	153	20	30	30	160	254.4	72.7	168.9	26.3	34.8	89.0	6.5	5.4
Exp. Apr. 21-May 9	not gr	256	36	54	54	288	444.4	130.9	294.2	46.6	59.3	155.7	11.6	5.3
V. Pre. Feb. 14-24	not gr	113	40	40	...	236	243.7	72.7	162.4	15.9	29.1	104 8	5.7	9.3
Exp. Feb. 24-Mch. 14	not gr	195	72	72	...	428	423.2	130.6	288.7	28.2	51.4	187.2	10.3	9.2
VI. Pre. Mch. 14-24	gr	112	40	40	...	240	236.9	72.3	162.8	15.8	29.2	105.2	5.7	9.3
Exp. Mch. 24-Apr. 11	gr	204	72	72	...	432	428.0	129.9	294.1	28.6	52.9	190.0	10.5	9.3
VII. Pre. Apr. 11-21	not gr	113	40	40	...	240	243.1	72.1	167.1	16.7	31.4	100.7	6.1	8.7
Exp. Apr. 21-May 9	not gr	191	72	72	...	428	429.0	130.0	293 6	29.4	54.3	177.6	10.8	8.8
V. Pre. Feb. 14-24	gr	85	40	40	...	230	217.4	72.7	147.0	14.6	24 4	97.0	5.4	9.1
Exp. Feb. 24-Mch. 14	gr	160	72	72	...	423	391.4	130.6	270.1	26.6	45.4	177.7	10.0	9.2
VI. Pre. Mch. 14-24	not gr	87	40	40	...	221	209.9	72.3	146.0	14.4	24.3	96.2	5.4	9'1
Exp. Mch. 24-Apr. 11	not gr	162	72	72	...	411	386.0	129.9	268.4	26.5	45.2	176.5	9.9	9.1
VII. Pre. Apr. 11-21	gr	89	40	40	...	228	218.6	72.1	152.1	15.4	26.9	93.3	5.8	8.6
Exp. Apr. 21-May 9	gr	167	72	72	...	407	401.5	130.0	276.6	27.9	49.3	169.1	10.5	8.6

EXPERIMENTAL ERROR BROWNIE, RACHEL, STAR BRIGHT, MAX BELLE Period numbers and dates	Nature of ration	Pounds eaten of						Total dry matter in entire ration	Total dry matter in experimental feed (grain)	Pounds of digestible nutrients eaten during period					Nutritive ratio, 1 :
		Hay	Corn meal	Bran	½ cottonseed meal ½ linseed meal	Buffalo gluten feed	Silage			Dry matter	Protein	Crude fiber	Nitrogen-free extract	Ether extract	
III. Pre. Jan. 3-15	IV	180	48	48	....	....	....	242.4	86.5	156.0	17.6	43.1	92.3	5.3	8.4
Exp. jan. 15-Feb. 7	IV	348	92	92	....	....	....	469.0	165.7	300.5	33.8	83.1	177.7	10.1	8.4
IV. Pre. Feb. 7-19	IV	182	48	48	....	....	....	246.3	87.1	156.6	16.9	41.1	95.2	5.2	8.8
Exp. Feb. 19-Mch. 14	IV	349	92	92	....	....	....	470.1	167.0	299.5	30.9	75.3	187.0	9.7	9.3
V. Pre. Mch. 14-26	IV	181	48	48	....	....	....	242.7	86.7	155.8	16.1	39.2	97.3	5.0	9.2
Exp. Mch. 26-Apr. 18	IV	350	92	92	....	....	....	467.6	165.9	301.4	32.0	79.3	184.7	10.0	9.0
III. Pre. Jan. 3-15	IV	178	48	48	....	....	130	277.0	86.5	182.4	19.6	48.8	109.1	6.2	8.8
Exp. Jan. 15-Feb. 7	IV	307	92	92	....	....	323	523.5	165.7	347.8	37.1	90.9	210.9	11.9	9.0
IV. Pre. Feb. 7-19	IV	128	48	48	....	....	182	256.4	87.1	168.5	17.5	40.5	107.0	6.0	9.2
Exp. Feb. 19-Mch. 14	IV	241	92	92	....	....	354	478.3	167.0	322.7	32.4	73.1	209.7	11.6	9.5
V. Pre. Mch. 14-26	IV	134	48	48	....	....	192	256.1	86.7	174.1	17.4	39.8	112.6	6.1	9.6
Exp. Mch. 26-Apr. 18	IV	260	92	91	....	....	368	496.6	164.8	337.8	34.1	79.7	211.0	12.1	9.3
VI. Pre. Apr. 18-30	IV	127	40	41	....	....	186	243.8	75.0	163.8	16.6	39.8	98.9	5.8	9.1
Exp. Apr. 30-May 23	IV	234	92	90	....	....	367	481.6	162.1	325.6	33.4	77.4	199.7	12.1	9.1
III. Pre. Jan. 3-15	B.G	106	....	....	....	84	220	230.4	77.1	164.4	26.6	32.1	93.8	4.4	5.1
Exp. Jan. 15-Feb. 7	B.G	217	....	....	....	161	436	458.7	147.8	325.7	52.0	64.5	185.1	8.7	5.2
IV. Pre. Feb. 7-19	B.G	101	....	....	....	84	219	235.2	77.8	164.1	26.1	29.9	95.5	4.6	5.2
Exp. Feb. 19-Mch. 14	B.G	205	....	....	....	159	449	454.6	147.2	324.4	50.5	60.4	287.1	9.1	5.3
V. Pre. Mch. 14-26	B.G	113	....	....	....	84	239	242.2	77.7	173.7	27.0	32.7	101.3	4.8	5.3
Exp. Mch. 26-Apr. 18	B.G	213	....	....	....	157	448	460.2	145.3	329.4	51.2	63.1	186.4	9 2	5.3
VI. Pre. Apr. 18-30	B.G	104	....	....	....	84	240	242.2	77.1	174.4	27.3	32.9	95.3	4.9	5.1
Exp. Apr. 30-May 23	B.G	195	....	....	....	161	458	461.3	147.5	330.8	52.0	62.3	181.4	9.3	5.1
I. Pre. Oct. 25-Nov. 6	II	162	12	36	36	....	230	291.6	76.3	186.8	27.6	40.4	102.0	6.9	5.7
Exp. Nov. 6-29	II	329	23	69	69	....	531	595.4	146.2	393.8	55.9	84.9	218.4	13.2	6.1
II. Pre. Nov. 29-Dec. 11	II	169	12	36	36	....	273	304.4	76.5	203.2	28.9	43.7	112.7	6 9	6.0
Exp. Dec. 11-Jan. 3	II	317	23	69	69	....	521	575.5	148.1	379.7	57.3	81.9	200.3	14.0	5.5
III. Pre. Jan. 3 15	II	173	12	36	36	....	259	298.8	76.6	197.1	30.1	43.4	104.6	7.3	5.5
Exp. Jan. 15-Feb. 7	II	341	23	69	69	....	516	587.9	146.6	387.0	58.4	85.7	205.3	14.2	5.5
IV. Pre. Feb. 7-19	II	167	12	36	36	....	265	306.4	76.8	198.2	29.1	40.2	109.2	7.7	5.8
Exp. Feb. 19-Mch. 14	II	324	23	69	69	....	423	550.4	147.1	361.1	54.3	74.2	198.2	14.1	5.7
V. Pre. Mch. 14-26	II	175	12	36	36	....	192	282.2	76.6	185.5	28.2	38.5	101.2	7.1	5.5
Exp. Mch. 26-Apr. 18	II	336	23	69	69	....	368	543.6	146.1	357.4	55.9	75.5	189.9	13.7	5.3
VI. Pre. Apr. 18-30	II	173	12	36	36	....	187	285.7	76.2	187.2	29.9	39.8	95.9	7.0	5.1
Exp. Apr. 30-May 23	II	309	23	69	69	....	386	537.1	146.1	353.0	56.8	73.7	181.9	14.0	5.1

V. RECORDS SHOWING PRODUCTION AND SAME PER UNIT FOR EACH INDIVIDUAL COW IN FEEDING TESTS

Name of cow	Period numbers	Experimental fodder	Preliminary portion			Experimental portion of period							Weight of products obtained per 100 lbs. of dry matter eaten					
													In entire ration			In experimental fodder		
			Dry matter eaten 1	Dry matter eaten 2	Milk.	Dry matter eaten 1	Dry matter eaten 2	Milk	Total solids	Fat	Total solids	Fat	Milk	Total solids	Fat	Milk	Total solids	Fat
			lbs	lbs	lbs	lbs	lbs	lbs	%	%	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs
SUE	I	II	295.8	82.2	236.6	599.7	146.7	478.9	13.39	4.17	64.12	19.99	79.9	10.7	3.3	326.4	43.7	13.6
	II	B G	324.3	87.9	273.6	591.4	168.9	518.3	13.28	4.03	68.84	20.87	87.7	11.6	3.5	306.9	40.8	12.4
	III	II	296.3	72.9	241.4	601.9	146.6	457.8	13.71	4.40	62 76	20.16	76.1	10.4	3.4	312.3	42.8	13.8
	IV	B G	330.8	88 9	228.1	600.4	170.4	441.4	13.60	4.44	60.02	19.61	73.5	10.0	3.3	259.0	35.2	11.5
	V	II	312.6	76.6	216.0	612.3	146.1	390.1	14.45	4.98	56.38	19.43	63.7	9.2	3 2	267.0	38.6	13.3
	VI	B G	328.0	88.1	205.6	616.5	168 6	365.7	13.91	4.76	50.88	17.41	59.3	8.3	2.8	216.9	30.2	10.3
HAIDEE	I	B G	258.6	83.5	189.7	506.2	147.9	392.6	15.39	5.61	60.44	22.03	77.6	11.9	4.4	265 4	40.9	14.9
	II	II	258.2	76.5	189.7	492.2	148.1	355.2	15.71	5.82	55.81	20.67	72.2	11.3	4.2	239.8	37.7	14.0
	III	B G	265.9	87 2	193.1	517.7	168.9	383.7	15.86	5.89	60.85	22.60	74.1	11.8	4.4	227.2	36.0	13.4
	IV	II	270.8	76.8	188.8	500.3	148.1	356.6	15.91	6.10	56.75	21.74	71.3	11.3	4.4	240.8	38.3	14.7
	V	B G	266.6	88.8	192.0	514.8	167.5	361.3	15.95	6.08	57.63	21.96	70.2	11.2	4 3	215.7	34.4	13.1
	VI	II	271.7	76.2	192.0	503.6	146.1	362.1	15.43	5.89	55 88	21.33	71.9	11.1	4.2	247.8	38.3	14.6
ATALANTA	II	B G	328.1	87.9	457.4	647.3	168.9	852.9	12.72	3.95	108.47	33.72	131.7	16.8	5.2	504.9	64.2	20.0
	III	II	296 8	73.8	381.6	615.1	146.9	709.8	12.29	3.77	87.25	26.78	115.4	14.2	4.4	484.2	59.5	18.3
	IV	B G	341.1	88.9	389.2	619.8	170.4	745.3	12.20	3.68	90.91	27.41	120.2	14.7	4.4	437.4	53.4	16.1
	V	II	315.7	76 6	358.9	615.8	146.1	678.9	12.30	3.78	83.53	25.63	110.2	13.6	1.2	464.7	57.2	17.5
	VI	B G	333.0	88.1	376.9	607.7	168.6	732.6	12.21	3.67	89.47	26.90	120.5	14.7	1.4	434.5	53.1	16.0
NANCY B.	II	II	360.4	76.5	388.4	706.6	148.1	758.8	12.65	3.71	96.03	28.12	107.4	13.6	4.0	512.3	64 8	19.0
	III	B G	368.3	87.2	391.8	736.5	168.9	751.4	12.96	4.01	97.36	30.13	102.0	13.2	4.1	444.9	57.6	17.8
	IV	II	384.9	76.8	367.5	679.2	147.1	694.6	12.45	3.81	86.48	26.48	102.3	12.7	3.9	472.2	58.8	18.0
	V	B G	380.4	88.8	372.9	740.6	170.2	707.3	12.75	3.99	90.16	28.24	95.5	12.2	3.8	415.6	53.0	16.6
	VI	II	376.2	76.2	351.3	699.7	146.1	679.1	12.36	3.84	83.95	26.05	97.1	12.0	3.7	464.8	57.5	17.8
GOLDIE	I	II	310.4	76.3	231.2	649.4	146.7	462.0	15.32	5.65	70.79	26.10	71.1	10.9	1 0	314.9	48.3	17.8
	II	B G	329.0	87.9	271.6	597.7	168.9	523.6	15.18	5.43	79.48	28.45	87.6	13.3	4.8	310.0	47.1	16.8
	III	II	295.4	77.5	248.8	596.9	146.6	476.1	15.23	5.49	72.50	26.15	79 8	12.2	4.4	324.8	49.5	17.8
	IV	B G	326.0	88.9	265.3	605.3	170.4	487.5	15.17	5.50	73.95	26.83	80.5	12.2	4.4	286.1	43.4	15.8
	V	II	299.0	76.6	227.4	592.4	144.3	427.8	15.53	5.82	66.43	24.91	72.2	11.2	4 2	296.4	46.0	17.3
	VI	B G	315.5	88.1	251.9	581.9	168.6	512.0	14.46	5.24	74.04	26.84	88.0	12.7	4.6	303.7	44.0	15.9
EVA	I	B G	301.2	88.0	230.1	625.0	168.1	429.9	16.40	6.46	70.52	27.75	68.8	11.3	4.4	255.7	42 0	16.5
	II	II	313.9	76.5	230.2	603.2	148.1	411.1	16.67	6.70	68.54	27.53	68.2	11.4	4.6	277.6	46.3	18.6
	III	B G	306.2	84.5	211.3	602.5	168.0	438.1	17.01	6.87	74.51	30.08	72.7	12.4	5.0	260.8	44.4	17.9
	IV	II	316.6	76.8	210.2	586.7	147.1	386.7	17.01	7.09	65.77	27.42	65.9	11.2	4.7	262.9	44.7	18.6
	V	B G	322.2	87.9	209.7	610.1	162.8	373.3	17.66	7.55	65.94	28.18	61.2	10.8	4.6	229.3	40.5	17.3

1 In entire ration.

2 In experimental portion of ration.

Name of cow	Period numbers	Experimental fodder	Preliminary portion			Experimental portion of period							Weight of products obtained per 100 lbs of dry matter eaten					
													In entire ration			In experimental fodder		
			Dry matter eaten 1	Dry matter eaten 2	Milk	Dry matter eaten 1	Dry matter eaten 2	Milk	Total solids	Fat	Total solids	Fat	Milk	Total solids	Fat	Milk	Total solids	Fat
			lbs	lbs	lbs	lbs	lbs	lbs	%	%	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs
ACME.	III	II	304.6	76.6	452.4	597.2	146.6	840.4	12.23	3.92	102.77	32.98	140.7	17.2	5.5	573.3	70.1	22.5
	IV	B G	324.4	88.9	405.8	572.6	170.4	723.8	11.58	3.61	83.84	26.12	126.4	14.6	4.6	424 8	49 2	15.3
	V	II	303.7	76.6	332.8	586.9	146.1	598.7	12.05	3.92	72.13	23.44	102.0	12.3	4.0	409.8	49.4	16.0
	VI	B G	295.2	88.1	288.9	558.2	162.2	580.5	11.32	3.52	65.73	20.45	104.0	11.8	3.7	357.8	40.5	12.6
G. ROD	I	IV	252.2	71.9	131.9	491.7	129.5	243.5	17.45	7.51	42.49	18.29	49.5	8.6	3.7	188.0	32.8	14.1
	II	O F	279.8	73.5	102.3	485 2	132.8	209.8	17.89	7.75	37.53	16.26	43.2	7.7	3.4	158.0	28.3	12.2
	III	IV	245.3	72.0	125.1	463.9	129.7	203.6	17.93	7.69	36.51	15.65	43.9	7.9	3.4	157.0	28.2	12.1
J. LILY	I	O F	252.1	73.7	134.3	488.7	132.1	250.6	15.89	6.34	39.82	15.89	51.3	8.2	3.3	189.7	30.1	12.0
	II	IV	263.7	72.0	148.3	480.6	129.7	257.6	15.89	6.30	40.93	16.24	53.6	8.5	3.4	198.6	31.6	12.5
	III	O F	263.0	73.6	143.3	467.1	132.2	259.5	16.26	6.21	42.21	16.11	55.6	9.0	3.5	196.3	31.9	12.2
VIOLA	III	IV	174.6	61.3	127.4	359.3	123.4	320.7	14.34	4.96	45.98	15.90	89.3	12.8	4.4	259.9	37.3	12.9
	IV	O F	193.1	67.5	161.5	407.3	127.3	325.4	14.23	5.10	46.29	16.58	79.9	11.4	4.1	255.6	36.4	13.0
	V	IV	211.4	67.8	163.5	409.7	124.4	324.7	14.76	5.28	47.94	17.14	79.3	11.7	4.2	261.0	38.5	13.8
	VI	O F	215.9	64.1	173.4	408.7	121.0	356.6	14.00	4.99	49.94	17.78	87.3	12.2	4.4	294.7	41.3	14.7
J'ANN'E	VI	O F	223.9	74.3	255.1	429.0	134.1	480.3	13.23	4.42	63.57	21.24	112.0	14.8	5.0	358.2	47.4	15.8
	VII	IV	240.2	72.1	271.1	416.3	130.0	480.3	12.35	3.92	59.30	18.85	115.4	14.2	4.5	369.5	45.6	14.5
	VIII	O F	242.3	74.1	263.2	431.5	132.7	429.8	12.48	3.96	53.64	17.02	99.6	12.4	3.9	323.8	40.4	12.8
CLOVER	VI	IV	270.0	72.3	304.3	477.4	129.9	510.1	14.27	4.80	72.82	24.49	106.8	15.3	5.1	392.7	56.1	18.9
	VII	O F	276.9	74.5	283.0	498.0	133.5	504.6	13.82	4.84	69.76	24.43	101.3	14.0	4.9	378.5	52.3	18.3
	VIII	IV	279.5	72.2	277.5	504.3	129.4	459.8	14.11	4.96	64.86	22.82	91.2	12.9	4.5	355 3	50.1	17.6

1 In entire ration.

2 In experimental portion of ration.

Name of cow	Period numbers	DATES	Nature of experimental ration	Dry matter eaten	Milk	Total solids	Fat	Total solids	Fat	Weight of products obtained per 100 lbs. of dry matter in entire ration: Milk	Total solids	Fat
				lbs	lbs	%	%	lbs	lbs	lbs	lbs	lbs
ACME	I	Pre. Jan. 29-Feb. 9, 1898	Br	345.4	502.0	13.08	4.48	65.64	22.48	145.4	19.0	6.5
		Exp. Feb. 9-March 8	Br	655.3	905.5	12.42	3.94	112.48	35.65	138.2	17.2	5.4
	II	Pre. March 8-23	Oil	367.2	483.4	12.16	4.01	58.79	19.37	131.6	16.0	5.3
		Exp. March 23-April 19	Oil	682.2	801.5	12.15	4.02	97.37	32.20	117.5	14.3	4.7
	III	Pre. April 19-May 1	Br	272.7	310.9	11.39	3.36	35.39	10.45	114.0	13.0	3.8
		Exp. May 1-24	Br	569.4	550.6	11.60	3.50	63.86	19.27	96.7	11.2	3 4
MINTA BELLA	I	Pre. Jan. 25-Feb. 9, 1898	Br	295.0	372.2	14.26	5.33	53.21	19.90	126.2	18.0	6.8
		Exp. Feb. 9-March 8	Br	601.8	642.1	14.12	5.09	90.68	32.70	106.7	15.1	5.4
	II	Pre. March 8-23	Oil	357.7	374.8	14.43	5.50	54.09	20.61	104.8	15.1	5.8
		Exp. March 23-April 19	Oil	629.0	644.1	14.45	5.47	93.05	35.25	102.4	14.8	5.6
	III	Pre. April 19-May 1	Br	312.4	251.7	13.81	4.85	34.76	12.20	80.6	11.1	3.9
		Exp. May 1-24	Br	555.6	470.0	14.13	5.13	66.40	24.11	84.6	12.0	4.3
RED TOP	I	Pre. Jan. 25-Feb. 9, 1898	Br	....	....	....	....	....	....	....	....	....
		Exp. Feb. 9-March 8	Br	641.6	903.4	13.14	4.04	118.69	36.45	140.8	18.5	5.7
	II	Pre. March 8-23	Oil	345.4	511.5	12.54	3.96	64.15	20.24	148.1	18.6	5.9
		Exp. March 23-April 19	Oil	700.0	756.4	12.46	3.97	94.23	30.06	108.1	13 5	4.3
	III	Pre. April 19-May 1	Br	314.2	246.1	11.82	3.64	29.10	8.95	78.3	9.3	2.9
		Exp. May 1-24	Br	698.1	443.8	12.51	4.06	55.50	18.04	63.6	8.0	2.6
POLLY	I	Pre. Jan. 25-Feb. 9, 1898	Br	346.9	238.0	14.91	5.59	35.48	13.30	68.6	10.2	3.8
		Exp. Feb. 9-March 8	Br	641.3	447.9	15.26	5.70	68.35	25.53	69.8	10.7	4.0
	II	Pre. March 8-23	Oil	385.3	277.4	15.43	6.02	42.80	16.69	72.0	11.1	4.3
		Exp. March 23-April 19	Oil	746.6	533 0	14.93	5.66	79.56	30.18	71.4	10.7	4.0
	III	Pre. April 19-May 1	Br	328.9	216.6	14 51	5.14	31.42	11.13	65.9	9.6	3.4
		Exp. May 1-24	Br	625.8	451.3	14.13	4.97	63.75	22.44	72.1	10.2	3.6
EULALIE	II	Pre. Nov. 29-Dec. 9	Oil	308.1	358.6	14.02	4.77	50.29	17.10	116.4	16.3	5.6
		Exp. Dec. 9-27	Oil	546.4	592.9	14.03	4.78	83.19	28.35	108.5	15.2	5.2
	III	Pre. Dec. 27-Jan. 11	IV	427.8	443.9	13.69	4.41	60.77	19.57	103 8	14.2	4.6
		Exp. Jan. 11-Feb. 7	IV	816.4	765.0	14.13	4.78	108.21	36.59	93.7	13.3	4.5
	IV	Pre. Feb. 7-19	Oil	384.5	355.9	14.52	5.37	51.68	19.10	92.6	13.4	5.0
		Exp. Feb. 19-March 14	Oil	707.5	670.4	14.04	4.99	94.12	33.48	94.8	13.3	4.7
	V	Pre. March 14-26	IV	359.9	351.1	13.58	4.51	47.70	15.82	97.6	13.3	4.4
		Exp. March 26-April 18	IV	700.8	628.3	14.17	4.81	89.00	30.20	89.7	12.7	4.3
ROSE	I	Pre. Oct. 25-Nov. 6	....	....	....	....	....	....	....	....	....	....
		Exp. Nov. 6-29	IV	406.8	281.7	14.42	4.92	40.62	13.87	69.3	10.0	3.4
	II	Pre. Nov 29-Dec. 9	Oil	198.6	145.9	15.05	5.53	21.96	8.07	73.5	11.1	4.1
		Exp. Dec. 9-27	Oil	271.8	257.1	14.84	5.38	38.15	13.83	94.6	14.0	5.1
	III	Pre. Dec. 27-Jan. 11	IV	250.6	213.0	14.36	4.77	30.59	10.15	85.0	12.2	4.1
		Exp. Jan. 11-Feb. 7	IV	489.6	358.7	15.00	5.32	53.79	19.07	73.3	11.0	3.9
	IV	Pre. Feb. 7-19	Oil	227.8	149.4	15.27	5.89	22.82	8.80	65.6	10.0	3.9
		Exp. Feb. 19-March 14	Oil	406.4	305.8	14.72	5.64	45.02	17.26	75.2	11.1	4.3
	V	Pre. March 14-26	IV	207.6	144.6	14.39	5.30	20.81	7.67	69.7	10.0	3.7
		Exp. March 26-April 18	IV	421.4	245.6	15.00	5.60	36.84	13.76	58.3	8.7	3.3

Name of cow	Period numbers	DATES	Nature of experimental ration	Dry matter eaten	Milk	Total solids	Fat	Total solids	Fat	Weight of products obtained per 100 lbs. of dry matter in entire ration: Milk	Total solids	Fat
				lbs	lbs	%	%	lbs	lbs	lbs	lbs	lbs
LALA	II	Pre. Nov. 29-Dec. 9	Oil	235.2	244.5	14.16	4.71	34.62	11.52	104.0	14.7	4.9
		Exp. Dec. 9-27	Oil	385.2	424.8	13.83	4.59	58.76	19.49	110.3	15.3	5.1
	III	Pre. Dec. 27-Jan. 11	IV	314.8	333.3	13.62	4.49	45.41	14.66	105.9	14.4	4.8
		Exp. Jan. 11-Feb. 7	IV	614.4	531.4	13.94	4.63	74.10	24.62	86.5	12.1	4.0
	IV	Pre. Feb. 7-19	Oil	322.0	213.9	14.30	5.19	30.58	11.10	66,4	9.5	3.5
		Exp. Feb. 19-March 14	Oil	608.2	384.3	14.27	5.26	54.84	20.20	63.2	9.0	3.3
DIME	III		IV	----	----	----	---	-----	----	---	---	---
		Exp. Jan. 11-Feb. 7	IV	548.8	164.9	13.25	3.90	88.26	25.93	121.1	16.1	4.7
	IV	Pre. Feb. 7-19	Oil	253.5	300.7	---	---	-----	----	---	----	---
		Exp. Feb. 19-March 14	Oil	479.4	554.5	13.09	4.13	72.61	22.92	115.7	15.1	4.8
	V	Pre. March 14-26	IV	248.8	286.9	12.61	3.53	36.17	10.14	115.3	14.5	4.1
		Exp. March 26-April 18	IV	482.3	531.6	12.74	3.74	67.74	19.86	110.2	14.0	4.1
EDNA	I	Pre. Oct. 25-Nov. 6	IV	299.9	271.6	13.66	4.53	37.11	12.29	90.6	12 4	4.1
		Exp. Nov. 6-29	IV	627.9	506.9	14.43	4.94	73.17	25.05	80.7	11.7	4.0
	II	Pre. Nov. 29-Dec. 9	Oil	273.1	237.0	14.33	5.03	33.97	11.92	86.8	12 4	4.4
		Exp. Dec. 9-27	Oil	466.6	423.6	13.78	4.52	58.36	19.13	90.8	12.5	4.1
	III	Pre. Dec. 27-Jan. 11	IV	349.3	334.7	13.84	4.36	46.34	14.59	95.8	13.3	4.2
		Exp. Jan. 11-Feb. 7	IV	719.3	601.1	14.32	4.74	86.08	28.50	83.6	12.0	4.0
	IV	Pre. Feb. 7-19	Oil	339.8	265.0	14.86	5.43	39.38	14.38	78 0	11.6	4.2
		Exp. Feb. 19-March 14	Oil	628.7	475.6	14.24	5.04	67.74	23.99	75.6	10.8	3.8
	V	Pre. March 14-26	IV	315 9	249.2	14.15	4.62	35.25	11.50	78.9	11.2	3.6
		Exp. March 26-April 18	IV	617.4	469.4	14.85	5.13	69.70	24.10	76.0	11.3	3.9
ANNIE	II	Pre. Nov. 29-Dec. 9	Oil	229.8	191.9	14.13	4.59	27.12	8.80	83.5	11.8	3.8
		Exp. Dec. 9-27	Oil	366.0	335.6	12.83	3.58	43.05	12 01	91.7	11.8	3.3
	III	Pre. Dec. 27-Jan. 11	IV	323.0	269.6	13.38	3.94	36.07	10.61	83.5	11.2	3.3
		Exp. Jan. 11-Feb. 7	IV	685.3	408.8	13.63	4.29	55.72	17.52	59.7	8.1	2.6
	IV	Pre. Feb. 7-19	Oil	295.8	171.9	13.74	4.50	23.64	7.74	58.1	8.0	2.6
		Exp. Feb. 19-March 14	Oil	576.0	291.7	12.97	3.99	37.85	11.65	50.6	6.6	2.0
	V	Pre. March 14-26	IV	285.6	135.9	13.54	4 09	18.40	5.56	47.6	6.4	2.0
		Exp. March 26-April 18	IV	564.3	283.1	13.93	4.62	39.43	13.08	50.2	7.0	2.3
CERES	I	Pre. Oct. 25-Nov. 6	IV	247.0	133.7	17.31	7.26	23.14	9.71	54.1	9.4	3.9
		Exp. Nov. 6-29	IV	538.2	251.3	17.51	7.38	44.00	18.55	46.7	8 2	3.5
	II	Pre. Nov. 29-Dec. 9	Oil	240.7	123.9	17.42	7.50	21.59	9.29	51.5	9.0	3.9
		Exp. Dec. 9-27	Oil	382.6	254.6	16.07	6.50	40.92	16.55	66.5	10.7	4.3
	III	Pre. Dec. 27-Jan. 11	IV	313.9	204.7	16.74	6.67	34.26	13.66	65.2	10.9	4.4
		Exp. Jan. 11-Feb. 7	IV	597.7	356.5	17.45	7.26	62.22	25.87	59.6	10.4	4.3
	IV	Pre. Feb. 7-19	Oil	283.4	166.7	17.67	7.67	29.46	12.78	58.8	10.4	4.5
		Exp. Feb. 19-March 14	Oil	478.2	300.0	15.64	6.24	46.91	18.73	62.7	9.8	3.9
ROWENA	I	Pre. Oct. 25-Nov. 6	IV	306.4	219.2	14.06	4.90	30.82	10.73	71.5	10 1	3.5
		Exp. Nov. 6-29	IV	629.5	453.3	13.95	4 73	63.23	21.42	72.0	10.0	3.4
	II	Pre. Nov. 29-Dec. 9	Oil	264.5	200.4	14.28	5.11	28.62	10.24	75.8	10.8	3.9
		Exp. Dec. 9 27	Oil	423.4	353.1	13.82	4.53	48 79	16,00	83.4	11.5	3.8
	III	Pre. Dec. 27-Jan. 11	IV	363.2	274.6	14.00	4.42	38.44	12.14	75.6	10.6	3.3
		Exp. Jan. 11-Feb. 7	IV	653.7	433.7	14.50	4.82	62.89	20.90	66.3	9.6	3.2
	IV	Pre. Feb. 7-19	Oil	308.7	164.5	15.48	5,66	25.46	9.31	53.3	8.3	3.0
		Exp. Feb. 19-March 14	Oil	592.3	319.0	14.99	5.48	47.81	17.47	53.9	8.1	3.0

Name of cow	Period numbers	DATES	Nature of experimental ration	Dry matter eaten	Milk	Total solids	Fat	Total solids	Fat	Weight of products obtained per 100 lbs. of dry matter in entire ration. Milk	Total solids	Fat
				lbs	lbs	%	%	lbs	lbs	lbs	lbs	lbs
RED TOP	I	Pre. Oct. 25-Nov. 6	IV	321.9	213.5	13.00	4.32	27.76	9.22	66.3	8.6	2.9
		Exp. Nov. 6-29	IV	625.6	370.5	13.46	4.68	49.88	17.34	59.2	8.0	2.8
	II	Pre. Nov. 29-Dec. 9	Oil	278.0	170.2	12.98	4.34	22.09	7.39	61.2	8.0	2.7
		Exp. Dec. 9 27	Oil	443.3	252.0	13.12	4.14	33.07	10.44	56.8	7.5	2.4
	III	Pre. Dec. 27-Jan. 11	IV	380.6	215.1	13.51	4.39	29.05	9.44	56.5	7.6	2.5
		Exp. Jan. 11-Feb. 7	IV	719.7	346.0	13.52	4.50	46.79	15.58	48.1	6.5	2.2
	IV	Pre. Feb. 7-19	Oil	338.0	135.9	14.44	5.23	19.57	7.11	40.2	5.8	2.1
		Exp. Feb. 19-March 14	Oil	650.4	223.4	14.05	5.08	31.40	11.35	34.4	4.8	1.8
MARJORY	I	Pre. Oct. 25-Nov. 6	IV	307.2	172.1	14.61	5.50	25.15	9.47	56.0	8.2	3.1
		Exp. Nov. 6-29	IV	622.1	342.2	14.68	5.42	50.22	18.54	55.0	8.1	3.0
	II	Pre. Nov. 26-Dec. 9	Oil	279.8	150.4	14.47	5.52	21.77	8.30	53.8	7.8	3.0
		Exp. Dec. 9-27	Oil	462.6	247.1	14.30	5.39	35.34	13.31	53.4	7.6	2.9
	III	Pre. Dec. 27-Jan. 11	IV	381.7	217.6	14.65	5.39	31.88	11.73	57.0	8.4	3.1
		Exp. Jan. 11-Feb. 7	IV	723.1	384.3	14.86	5.52	57.12	21.20	53.1	7.9	2.9
	IV	Pre. Feb. 7-19	Oil	336.8	169.0	15.15	6.02	25.60	10.18	50.2	7.6	3.0
		Exp. Feb. 19-March 14	Oil	615.3	327.5	14.42	5.56	47.23	18.21	53.2	7.7	3.0
	V	Pre. March 14-26	IV	312.4	173.3	14.77	5.42	25.59	9.40	55.5	8.2	3.0
		Exp. March 26-April 18	IV	611.6	340.0	15.25	5 69	51.86	19.34	55.6	8.5	3.2

Name of cow	Period numbers	Experimental fodder	Preliminary portion			Experimental portion of period							Weights of products obtained per 100 lbs of dry matter eaten					
													In entire ration			In experimental fodder		
			Dry matter eaten 1	Dry matter eaten 2	Milk	Dry matter eaten 1	Dry matter eaten 2	Milk	Total solids	Fat	Total solids	Fat	Milk	Total solids	Fat	Milk	Total solids	Fat
			lbs	lbs	lbs	lbs	lbs	lbs	%	%	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs
BETTIE	I	I	261.0	72.8	167.0	563.5	131.5	312.4	13.73	4.79	42.90	14.95	55.4	7.6	2.7	237.6	32.6	11.4
	II	O F	308.5	73.5	180.2	556.4	132.8	297 2	14.19	4.98	42.14	14.78	53.4	7.6	2.7	223.6	31.7	11.1
	III	I	299.9	72.7	145.1	533.7	131.2	233.9	15.33	5.52	35.85	12.90	43.8	6.7	2.4	178.3	27.3	9.8
FAIRIE	I	O F	243.1	73.7	137.1	482.1	132.1	245.1	14.58	5.28	35.75	12.93	50.8	7.4	2.7	185.5	27.1	9.8
	II	I	259.0	72.8	146.8	455.6	130.8	270.1	15.12	5.58	40.84	15.08	59.3	9.0	3.3	206.5	31.2	11.5
	III	O F	240.6	73.6	134.8	446.5	132.2	227.7	15.51	5.88	35.33	13.38	51.0	7.9	3.0	172.2	26.7	10.1
M. BELLA	III	II	241.5	76.6	177.6	489.7	146.6	364.3	16.67	6.71	60.73	24.46	74.4	12.4	5.0	248.5	41.4	16.7
	IV	O F	276.8	90.0	175.7	504.9	171.0	363.8	16.23	6.53	59.05	23.77	72.1	11.7	4.7	212.8	34.5	13.9
	V	I	263.2	87.5	193.2	526.5	167.0	359.2	16.35	6.63	58.72	23.80	70.8	11.6	4.7	215.1	35.2	14.3
	VI	O F	269.0	87.2	181.2	499.5	163.5	351.3	15.60	6.41	55.12	22.51	70.3	11.0	4.5	214.9	33.7	13.8
FLORA	V	I	255.9	73.2	437.5	47.62	131.7	779.0	13.08	4.39	101.91	34.16	163.6	21.4	7.2	591.5	77.4	25.9
	VI	O F	264.8	74.3	399.2	475.1	134.1	655.0	13.08	4.34	85.67	28.42	137.9	18.0	6 0	488.4	73.9	21.2
	VII	I	276.0	72.7	388.3	484.1	130.9	722.2	12.70	4.22	91.70	30.48	149.2	18.9	6.3	551.6	70.1	23.3
D'ndeli'n	VI	I	259.7	72.9	230.6	487.1	131.3	429.4	14.03	4.93	60.24	21.15	88.2	12.4	4.3	327.0	45.9	16.1
	VII	O F	275.7	71.5	227.9	485.7	133.3	386.6	13.19	4.64	51.01	17.92	79.6	10.5	3.7	290.0	38.3	13.4
	VIII	I	273.5	72.7	216.6	481.8	130.5	385.9	13.17	4.63	50.82	17.88	80.1	10.6	3.7	295.7	38.9	13.7
POLELA	IV	V	270.6	32.8	285.9	523.3	63.2	485.6	14.24	5.08	69.14	24.65	92.8	13.2	4.7	.....	...	...
	V	B G	329.1	88.8	289.1	641.0	170.2	543.1	14.93	5.36	81 02	29.09	84.7	12.6	4.5	.....	...	...
	VI	V	285.3	32.5	243.3	540.2	62.3	469.2	14.27	5.14	66.94	24.12	86.9	12.4	4.5	.....	...	...
PA'L'NE	III	B G	293.4	86.3	314.9	582.1	168.9	603.1	13.81	4.43	83.28	26.73	103.6	14.3	4.6	.....	...	...
	IV	V	250.7	32 8	263.5	468.1	65.9	456.2	13.73	4.57	62.66	20.85	97.5	13.4	4.5	.....	...	...
	V	B G	299.2	88.8	277.1	552.5	170.2	547.1	14.06	4.69	76.95	25.64	99.0	13.9	4.6	.....	...	...
INEZ	I	V	242.8	32.4	181.6	539.0	64.7	296.8	15.89	6.13	47.16	18.18	55.1	8.8	3.4	.....	...	...
	II	B G	308.4	87.9	171.5	616.3	168.9	376.2	15.65	5.81	58.86	21.86	61.0	9.6	3.6	.....	...	...
	III	V	272.5	40.4	171.7	526.5	62.0	299.4	15.80	5.97	47.32	17.87	56.9	9.0	3.4	.....	...	...
	IV	B G	330.2	84.3	173.2	624.3	166.6	337.4	15.33	5.77	51.74	19 47	54.0	8.3	3.1	.....	...	...
	V	V	250.1	32.9	143.5	526.7	62.8	232.5	16.70	6.82	38.84	15.85	44.1	7.4	3.0	.....	...	...
	VI	B G	320.9	81.7	141.1	567.9	138.4	295.5	15.37	6.01	45.43	17.76	52.0	8.0	3.1	.....	...	...
PRISC'L'A	II	V	246.8	32.4	252.5	480.3	61.9	444.3	14 97	5.28	66.50	23.44	92.5	13.8	4.9	.....	...	...
	III	B G	293.3	83.6	231.2	559.9	168.9	410.9	15.30	5.52	62.87	22.70	73.4	11.2	4.1	.....	...	...
	IV	V	263.5	32.8	178.3	460.3	63.2	301.3	15.86	6.14	47.80	18.51	65.5	10.4	4.0	.....	...	...
	V	B G	297.1	88.8	180.3	546.6	167.5	337.1	15.60	5.79	52.59	19.53	61.7	9.6	3.6	.....	...	...

1 In entire ration.

2 In experimental portion of ration.

Name of cow	Period numbers	Experimental fodder	Preliminary portion			Experimental portion of period							Weight of products obtained per 100 lbs of dry matter eaten					
													In entire ration			In experimental fodder		
			Dry matter eaten 1	Dry matter eaten 2	Milk	Dry matter eaten 1	Dry matter eaten 2	Milk	Total solids	Fat	Total solids	Fat	Milk	Total solids	Fat	Milk	Total solids	Fat
			lbs	lbs	lbs	lbs	lbs	lbs	%	%	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs
SYLVIA	I	V	239.4	32.4	114.9	548.6	65.5	194.7	16.06	6.20	31.27	12.07	35.5	5.7	2.2	-----	---	---
	II	B G	317.2	87.9	132.0	578.3	164.3	271.5	14.98	5.38	40.68	14.70	46.9	7.0	2.5	-----	---	---
	III	V	262.2	86.8	131.0	513.4	62.0	243.3	15.48	5.73	37.68	13.93	47.4	7.3	2.7	-----	---	---
	IV	B G	304.5	78.7	143.5	579.7	145.4	298.9	15.04	5.45	44.97	16.28	51.6	7.8	2.8	-----	---	---
	V	V	271.5	31.1	120.4	530.1	62.8	210.5	16.26	6.43	34.22	13.53	39.7	6.5	2.6	-----	---	---
	VI	B G	317.6	86.3	140.9	607.2	158.5	278.8	151.7	5.71	42.30	15.93	45.9	7.0	2.6	-----	---	---
ADAH	III	II	228.4	72.9	116.1	425.7	146.6	238.8	14.78	5.21	35.29	12.43	56.1	8.3	2.9	162.9	24.1	8.5
	IV	III	232.2	87.1	127.5	442.7	167.0	264.2	15.19	5.56	40.14	14.69	59.7	9.1	3.3	158.2	24.0	8.8
	V	II	217.9	76.6	144.1	402.5	138.9	261.0	15.08	5.42	39.37	14.15	64.8	9.8	3.5	187.9	28.3	10.2
	VI	III	234.7	84.7	136.0	417.0	148.7	255.7	14.31	5.33	36.60	13.63	61.3	8.8	3.3	171.9	24.6	9.2
MAIZIE	III	I	289.3	87.5	305.9	554.6	167.7	579.3	12.83	4.19	74.31	24.26	104.5	13.4	4.4	345.4	44.3	14.5
	IV	III	286.6	87.1	284.8	535.3	167.0	556.3	12.79	4.19	71.15	23.30	103.9	13.3	4.4	333.1	42.6	14.0
	V	I	277.4	76.6	259.8	533.9	145.1	506.7	13.26	4.37	67.20	22.13	94.9	12.6	4.2	349.2	46.3	15.3
	VI	III	320.4	86.5	257.6	590.1	165.8	519.3	12.75	4.13	66.24	21.45	88.0	11.0	3.6	313.2	40.0	12.9
SALIDA	VI	I	240.4	63.8	257.7	428.5	114.9	449.9	14.48	4.99	65.17	22.47	105.0	15.2	5.2	39.15	56.7	19.6
	VII	III	250.4	71.3	224.6	439.0	129.6	380.6	14.04	5.03	53.44	19.16	86.7	12.2	4.4	29.36	41.2	14.8
	VIII	I	233.7	72.7	216.1	452.2	130.5	364.8	13.63	4.77	49.74	17.40	80.7	11.0	3.9	27.95	38.1	13.3
NAOMI	V	I	249.4	73.2	271.9	448.3	131.7	479.1	13.76	4.47	65.92	21.43	106.9	14.7	4.8	36.38	50.1	16.3
	VI	III	259.5	72.6	255.5	464.8	126.4	445.5	14.16	4.60	63.09	20.48	95.8	13.6	4.4	35.24	49.9	16.2
	VII	I	265.6	71.8	251.6	468.9	130.9	468.8	13.36	4.35	62.63	20.40	100.0	13.4	4.4	35.81	47.8	15.6
MAX ELLA	II	IV	----	---	----	464.4	129.7	581.0	13.34	4.09	77.51	23.74	125.1	16.6	5.1	44.80	59.8	18.3
	III	III	257.9	7.11	315.9	453.4	129.9	526.0	13.49	4.37	70.97	23.00	116.0	15.7	5.1	40.49	54.6	17.7
	IV	IV	256.7	72.0	271.4	462.1	129.7	472.0	13.46	4.48	63.55	21.13	102.2	13.8	4.6	36.39	49.0	16.3
	V	III	248.4	65.4	268.9	461.0	130.7	459.3	13.59	4.56	62.40	20.94	99.6	13.5	4.5	35.14	47.7	16.0
	VI	IV	251.5	72.3	260.1	470.9	129.9	434.0	14.00	4.74	60.79	20.55	92.2	12.9	4.4	33.41	46.8	15.8

1 In entire ration.

2 In experimental portion of ration.

Name of cow.	Period numbers	Experimental fodder or manner of watering	Dry matter eaten	Milk	Total solids	Fat	Total solids	Fat	WEIGHT OF PRODUCTS OBTAINED PER 100 POUNDS OF DRY MATTER — IN ENTIRE RATION: Milk	Total solids	Fat	IN EXPERIMENTAL FODDER: Milk	Total solids	Fat
			lbs	lbs	%	%	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs
ORPHA	VI	IV	197.7	183.5	13.79	4.65	25.31	8.53	92.8	12.8	4.3	253.8	35.0	11.8
		IV	397.4	332.9	14.13	4.60	47.04	15.31	83.8	11.8	3.9	256.2	36.2	11.8
	VII	B M	243 6	185.6	13.90	4.60	25.80	8.54	76.2	10.6	3.5	257.8	35.8	11.9
		B M	422.8	318.8	14.08	4.97	44.89	15.85	75.4	10.6	3.7	254.8	35.9	12.7
	VIII	IV	241.3	179.6	13.52	4.34	24.28	7.79	74.4	10.0	3.2	248.8	33.6	10.8
		IV	423.0	281.8	13.62	4.50	38.38	12.68	66.6	9.1	3.0	217.8	29.7	9.8
t. PERTUSIA	I	Si	199.6	179.7	15.61	6.00	28.05	10.78	90.0	14.1	5.4	----	----	----
		Si	423.8	352.1	15.32	5.73	53.94	20.18	83.1	12.7	4.8	----	----	----
	II	Art	318.1	295.4	----	----	----	----	----	----	----	----	----	----
		Art	587.8	519.1	15.71	5.75	81.56	29.85	88.3	13.9	5.1	----	----	----
	III	Si	337.4	269.7	15.85	5.83	42.75	15.72	79.9	12.7	4.7	----	----	----
		Si	634.5	469.6	15.90	6.01	74.66	28.22	94.0	11.8	4.5	----	----	----
HAZEL	IV	yard	183.6	127.7	14.68	5.06	18.75	6.46	69.6	10.2	3.5	202.4	29.7	10.2
		yard	328.3	213.8	14.81	5.29	31.67	11.31	65.1	9.7	3.5	188.4	27.9	10.0
	V	will	188.2	122.0	14.70	5.21	17.94	6.36	64.8	9.5	3.4	191.8	28.2	10.0
		will	333.9	214.0	14.89	5.42	31.83	11.59	64.1	9.5	3.5	187.2	27.9	10.1
	VI	yard	179.0	104.0	15.57	5.84	16.19	6.07	58.1	9.0	3.4	174.2	27.1	10.2
		yard	324.4	180.0	16.07	6.31	29.02	11.35	55.5	9.0	3.5	166.4	26.8	10.5
	VII	will	197.9	113.4	15.19	6.21	17.23	7.04	57.3	8.7	3.6	165.5	25.2	10.3
		will	363.3	226.3	15.15	5.81	34.30	13.15	62.3	9.4	3.6	174.0	26.4	10.1
LILAC	V	will	196.7	158.6	13.78	4.43	21.86	7.02	80.6	11.1	3.6	218.2	30.1	9.7
		will	353.4	285.4	13.80	4.53	39.38	12.93	80.8	11.1	3.7	218.5	30.2	9.9
	VI	yard	195.6	154.5	14.37	4.83	22.20	7.47	79.0	11.4	3 8	213.7	30.7	10.3
		yard	356.5	269.6	14.14	4.63	38.13	12.48	75.6	10.7	3.5	209.0	29.6	9.7
	VII	will	202.1	149.4	14.04	4.73	20.97	7.06	73.9	10.4	3.5	209.8	29.5	9.9
		will	365.7	281.5	13.36	4.40	37.60	12.39	77.0	10.3	3.4	216.5	28.9	9.5
CLARE	IV	----	----	----	----	----	----	----	----	----	----	----	----	----
		yard	458.5	590.5	13.88	4.58	81.94	27.02	128.8	17.8	5.5	455.3	63.2	20.8
	V	will	283.0	334.0	13.67	4.60	45.66	15.36	118.0	16.1	5.4	459.4	62.8	21.1
		will	494.2	564.3	13.48	4.57	76.08	25.78	114.2	15.4	5.2	432.1	58.3	19.7
	VI	yard	274.9	312.2	14.06	5.03	43.89	15.69	113.6	16.0	5.7	431.8	60.7	21.7
		yard	495.7	548.4	14.07	4.81	77.18	26.37	110.6	15.6	5.3	422.1	59.4	20.3
	VII	will	281.5	302.6	13.96	4.94	42.25	14.95	107 5	15.0	5.3	419.7	58.6	20.7
		will	507.8	537.6	13 45	4.62	72.32	24 84	105.9	14.2	4.9	413.5	55.6	19.1
PUS. WILLOW	IV	----	----	----	----	----	----	----	----	----	----	----	----	----
		yard	467.8	341.7	15.33	5.79	52.40	19.77	73.0	11.2	4.2	271.0	41.6	15.7
	V	will	247.9	208.7	14.93	5.37	31.17	11.21	84.2	12.6	4.5	287.1	42.9	15.0
		will	444.3	364.8	14.97	5.50	54 62	20.06	82.1	12.3	4.5	279.3	41.8	15.4
	VI	yard	244.9	204.1	15.33	5.82	31.29	11.88	83.3	12.8	4.9	282.3	43.3	16.4
		yard	443.6	346.5	15.96	6.01	55.30	20.82	78.1	12.5	4.7	270.7	43.2	16.3
	VII	will	253.8	185.9	15.17	5.87	28.20	10.91	73.3	11.1	4.3	257.8	39.1	15.1
		will	429.8	301 9	14.99	5.79	45.25	17.47	70.2	10.5	4.1	232.2	34.8	13.4

Name of cow	Period numbers	Grooming or no grooming	Dry matter eaten	Milk	Total solids	Fat	Total solids	Fat	WEIGHT OF PRODUCTS OBTAINED PER 100 POUNDS OF DRY MATTER: IN ENTIRE RATION: Milk	Total solids	Fat	IN EXPERIMENTAL FODDER: Milk	Total solids	Fat
			lbs	lbs	%	%	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs
LEAH	V	no gr	193.1	128.0	14.90	5.60	19.07	7.17	66.3	9.9	3.7	174.9	26.1	9.8
		no gr	347.9	224.1	15.42	5.89	34.57	13.20	64.4	9.9	3.8	170.1	26.3	10.0
	VI	gr	189.0	122.0	15.61	5.91	19.04	7.21	64.6	10.1	3.8	185.7	29.0	11.0
		gr	352.4	244.3	15.80	5.93	38.60	14.48	69.3	11.0	4.1	191.3	30.2	11.3
	VII	no gr	199.9	141.4	15.42	5.80	21.80	8.20	70.7	10.9	4.1	207.3	32.0	12.0
		no gr	365.0	264.0	15.15	5.71	39.99	15.07	72.3	11.0	4.1	206.0	31.2	11.8
POLLY	V	gr	252.1	236.3	15.02	5.30	35.49	12.52	93.7	14.0	5.0	322.8	48.5	17.1
		gr	429.2	449.2	14.35	5.10	64.47	22.93	104.7	15.0	5.3	341.0	49.0	17.4
	VI	no gr	254.7	246.0	14.63	5.42	36.00	13.33	96.6	14.1	5.2	337.5	49.4	18.3
		no gr	479.4	445.4	14.73	5.35	65.60	23.83	92.9	13.7	5.0	339.2	50.0	18.2
	VII	gr	265.6	242.5	14.64	5.41	35.50	13.11	91.3	13.4	4.9	333.5	48.8	18.0
		gr	467.3	438.4	14.34	5.22	62.87	22.87	93.8	13.5	4.9	334.9	48.0	17.5
POMONA	V	no gr	248.6	287.0	14.53	5.45	41.70	15.64	115.4	16.7	6.3	392.1	57.0	21.4
		no gr	434.7	493.7	14.04	4.95	69.31	24.42	113.6	15.9	5.6	374.8	52.6	18.5
	VI	gr	246.9	267.9	13.86	4.93	37.12	13.20	108.5	15.0	5.4	367.5	50.9	18.1
		gr	447.6	478.8	14.49	5.15	69.39	24.66	107.0	15.5	5.5	369.7	53.6	19.0
	VII	no gr	254.4	258.7	14.22	5.09	36.78	13.16	101.7	14.5	5.2	355.9	50.6	18.1
		no gr	444.4	473.7	13.92	4.90	65.96	23.21	106.6	14.8	5.2	361.8	50.4	17.7
L. PERUSIA	V	no gr	243.7	169.2	15.94	6.25	26.97	10.57	69.4	11.1	4.3	232.7	37.1	14.5
		no gr	423.2	296.5	16.60	6.55	49.22	19.42	70.1	11.6	4.6	227.0	37.7	14.9
	VI	gr	236.9	163.9	-- --	-- --	-- --	-- --	69.2	-- -	--	226.7	-- -	-- -
		gr	428.0	288.4	16 99	6.82	49.00	19.67	67.4	11.5	4.6	220.0	37.7	15.1
	VII	no gr	243.1	166.9	16.20	6.47	27.04	10.80	68.7	11.1	4.4	231.5	37.5	15.0
		no gr	429.0	289.1	15.54	6.14	44.94	17.75	67.4	10.5	4.1	222.4	34.6	13.7
BON. BELLE	V	gr	217.4	151.3	14.38	5.00	21.76	7.57	69.6	10.0	3.5	208.1	29.9	10.4
		gr	391.4	279.4	14.54	5.04	40.61	14.08	71.4	10.4	3.6	214.0	31.1	10.8
	VI	no gr	209.9	134 9	-- --	-- --	-- --	-- --	64.3	-- -	--	186.6	-- -	-- -
		no gr	386.0	288.4	14.92	5.26	43.03	15.17	74.7	11.2	3.9	222.0	33.1	11.7
	VII	gr	218.6	162 9	14.64	5.13	23.85	8.36	74.5	10.9	3.8	225.9	33.1	11.6
		gr	401.5	289.8	14.62	5.10	42.37	14.78	72.2	10.6	3.7	222.9	32.6	11.4

Name of cow	Period numbers	Experimental fodder	Preliminary portion			Experimental portion of period.							Weight of products obtained per 100 lbs of dry matter eaten					
													In entire ration			In experimental fodder		
			Dry matter eaten 1	Dry matter eaten 2	Milk	Dry matter eaten 1	Dry matter eaten 2	Milk	Total solids	Fat	Total solids	Fat	Milk	Total solids	Fat	Milk	Total solids	Fat
			lbs	lbs	lbs	lbs	lbs	lbs	%	%	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs
BROWNIE	III	IV	242.4	86.5	90.0	469.0	165.7	170.5	14.78	5.38	25.22	9.17	36.4	5.4	2.0	102.9	15 2	5.5
	IV	IV	246.3	87.1	88.2	470.1	167.0	162.5	14.78	5.40	24.01	8.77	34.6	5.1	1.9	97.3	14.4	5.3
	V	IV	242.7	86.7	80.4	467.6	165.9	162.8	14.70	5.35	23.94	8.71	34.8	5.1	1.9	98.1	14.4	5.3
RACHEL	III	IV	277.0	86.5	202.3	523.5	165.7	389.3	15.93	6.07	62.02	23.63	74.4	11.9	4.5	234.9	37.4	14.3
	IV	IV	256.4	87.1	198.9	478.3	167.0	398.4	15.67	5.97	62.44	23.77	83.3	13 1	5.0	238.6	37.4	14.2
	V	IV	256.1	86.7	207.7	496.6	164.8	387.8	16.07	6.11	62.31	23.69	78.1	12.6	4.8	235.3	37.8	14.4
	VI	IV	243.8	75.0	207.5	481.6	162.1	413.9	14.97	5.63	61.96	23.29	85.9	12.9	4.8	255.3	38.2	14.4
ST'R BR'T	III	B G	230.4	77.1	233.7	458 7	147.8	442.1	15.10	5.36	66,60	23.64	96.4	14.5	5.2	299.1	45.1	16.0
	IV	B G	235.2	77.8	214.0	454.6	147.2	418.8	15.09	5.45	63.21	22.81	92.1	13.9	5.0	284.5	42.9	15.5
	V	B G	242.2	77.7	214.6	460.2	145.3	383.6	15.66	5.81	60.08	22.29	83.4	13.1	4.8	264.0	41.4	15.3
	VI	B G	242.2	77.1	203.8	461.3	147.5	397.5	14.85	5.51	59.05	21.92	86.2	12.8	4.8	269.5	40.0	14.9
MAX BELLH	I	II	291.6	76.3	179.7	595.4	146.2	327.5	15.56	5.77	50.97	18.89	55.0	8.6	3.2	224.0	34.9	12.9
	II	II	304.4	76.5	168.0	575.5	148.1	297.1	16.34	6.24	48.54	18.54	51.6	8.4	3.2	200.6	32.8	12.5
	III	II	298.8	76.6	146.0	587.9	146.6	278.7	16.82	6.66	46.88	18.56	47.4	8.0	3.2	190.1	32.0	12.7
	IV	II	306.4	76.8	140.3	550.4	147.1	268.2	16.71	6.81	44.83	18.25	48.7	8.2	3.3	182.3	30.5	12.4
	V	II	282.2	76.6	135.8	543.6	146.1	261.1	16.89	6.99	44.09	18.16	48.0	8.1	3.3	178.7	30.2	12.4
	VI	II	285.7	76.2	153.0	537.1	146.1	288.1	15.86	6.45	45.69	18.58	53.6	8.5	3.5	197.2	31.3	12.7

1 In entire ration.

2 In experimental portion of ration.

VI. DIFFERENCE TABLES.[1] (*a*) TOTAL OF DIFFERENCES; (*b*) PERCENTAGE DIFFERENCES

(Showing differences in experimental feeding between the average of the results of two periods on one ration and those actually obtained with another ration in the intervening period.)

(*a*) TOTALS OF DIFFERENCES

Nature of experiment	FEEDS	Periods represented	Total dry matter eaten	Dry matter eaten in experimental fodder	WEIGHT OF PRODUCTS OBTAINED PER 100 LBS. OF DRY MATTER: IN ENTIRE RATION: Milk	IN ENTIRE RATION: Total solids	IN ENTIRE RATION: Fat	IN EXPERIMENTAL FODDER: Milk	IN EXPERIMENTAL FODDER: Total solids	IN EXPERIMENTAL FODDER: Fat	Total solids	Fat	Milk	Total solids	Fat
			lbs	lbs	lbs	%	%	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs
Equal balance	B. G. (act) ± II (calc)	11	+ 90.2	+247.8	+326.4	−0.47	−0.83	+44.34	+12.52	+43.7	+5.6	+1.5	−333.0	−46.0	− 17.1
	II (act) ± B. G. (calc)	12	−116.3	−252.7	−465.6	+1.54	+1.31	−57.34	−15.76	−60.4	−7.0	−1.8	+236.5	+37.7	+ 15.4
Unemul. C. S. oil (1898)	Oil (act) ± bran (calc)	2	+ 19.1	.....	+ 62.0	+0.23	+0.33	+10.55	+ 6.64	+ 6.7	+1.3	+1.0	.....	.....	.....
Emul. C. S. oil (1898)	Oil (act) ± bran (calc)	2	+ 24.0	.....	+ 79.4	−0.06	+0.12	+ 8.76	+ 4.68	+ 6.4	+0.5	+0.3	.....	.....	.....
Emul. C. S. oil	IV (act) ±C.S.oil(calc)	3	+ 49.0	.....	− 66.2	+0.20	−0.60	− 8.53	− 5.06	−19.9	−2.7	−1.5	.....	.....	.....
	C.S.oil(act) ±IV(calc)	4	− 50.1	.....	+ 78.9	−0.17	+0.94	+10.85	+ 7.50	+35 8	+5.0	+2 8	.....	.....	.....
Emul. Co. oil	IV (act) ±Corn oil(cal)	3	+ 68.9	.....	− 13.6	+2.63	+1.35	+ 5.14	+ 2.80	− 5.4	−0.7	+0.1	.....	.....	.....
	Cornoil(act)±IV(calc)	4	− 34.2	.....	+ 31.6	−3.17	−1.51	− 3.35	− 1.51	+ 3.4	+0.1	−0.2	.....	.....	.....
Emul. L. oil	IV (act)±Lin.oil(calc)	3	+ 6.1	.....	+ 9.6	+0.52	−0.21	+ 3 14	+ 0.18	+ 0 3	−0.1	−0.2	.....	.....	.....
	Lin oil(act)±IV (calc)	4	−103.3	.....	+ 2.9	−1.89	−0.83	− 4.71	− 2.30	+15.4	+1.0	+0.2	.....	.....	.....
Med. & scant.	B. G. (act) ± V (calc)	6	+485.2	+606.9	+377.8	−2.20	−2.03	+54.20	+17.11	+11.1	+2.1	−0.1	.....	.....	.....
	V (act) ± B. G. (calc)	6	+484.4	−586.3	−433.3	+3.48	+2.76	−59.69	−17.66	−26.4	−2.5	−0.2	.....	.....	.....
Oat feed	O. F. (act) ± I (calc)	4	+ 10.7	+ 20.8	− 90.9	−0.84	−0.43	−13.58	− 5.01	−19.9	−3.0	−1.1	−107.0	−16.0	− 5.9
	I (act) ± O. F. (calc)	2	− 4.4	− 1.7	+ 35.3	+0.46	+0.16	+ 6.93	+ 2.58	+ 8.1	+1.5	+0 6	+ 28.8	+ 5.4	+ 2.0
Oat feed	O. F. (act) ± IV (calc)	3	+ 37.3	+ 10.2	+ 8.5	−0.49	+0 09	− 1.72	+ 0.13	− 5.6	−1.5	−0.4	− 14.9	− 4.5	− 1.3
	IV (act) ± O. F. (calc)	3	− 9.6	− 5.7	+ 11.4	−0.06	−0.02	+ 0.42	− 0.08	+ 9.4	+0.4	+0.1	+ 19.9	+ 2.0	+ 0.5

1 See explanatory statement at the end of this appendix.

Nature of experiment	FEEDS	Periods represented	Total dry matter eaten	Dry matter eaten in experimental fodder	WEIGHT OF PRODUCTS OBTAINED PER 100 LBS. OF DRY MATTER								
					IN ENTIRE RATION			IN EXPERIMENTAL FODDER					
					Milk	Total solids	Fat	Milk	Total solids	Fat	Total solids	Milk	Fat
			lbs	lbs	lbs	lbs	%	%	lbs	lbs	lbs	lbs	lbs	lbs	lbs
Bk'wht mid. B'kwht mid.	III (act) ± I (calc)	3	− 4.2	+ 12.6	− 42.0	+0.32	+0.25	− 4.82	− 1.12	− 9.7	− 1.1	−0.3	− 65.7	− 7.9	− 2.3
	I (act) ± III (calc)	1	− 28.8	− 21.3	− 31.1	+0.49	+0.21	− 1.50	− 0.25	− 1.1	−0.3	−0.2	+ 26.0	+ 5.0	+ 1.8
Bk'wht mid. B'kwht mid.	III (act) ± II (calc)	1	+ 28.6	+ 24.2	+ 14.3	+0.26	+0.24	+ 2.81	+ 1.40	− 0.8	0.0	+0.1	− 17.2	− 2.2	− 0.5
	II (act) ± III (calc)	1	− 27.4	− 19.0	+ 1.0	+0.33	−0.03	+ 1.00	− 0.01	+ 1.3	+0.9	+0.2	+ 22.8	+ 4.0	+ 1.2
Bk'wht mid.	III (act) ± IV (calc)	2	− 15.4	+ 1.1	+ 5.8	−0.05	+0.03	+ 0.67	+ 0.66	+ 4.7	+0.6	+0.3	+ 1.3	+ 0.1	+ 0.4
	IV (act) ± III (calc)	1	+ 4.9	− 0.6	− 20.7	−0.08	+0.01	− 3.14	− 0.84	− 5.6	−0.9	−0.2	− 14.3	− 2.2	− 0.6
B. M.	B. M. (act) ± IV (calc)	1	+ 12.6	− 4.6	+ 11.4	+0.20	+0.42	+ 2.18	+ 1.85	0.0	+0.2	+0.3	+ 20.8	+ 2.9	+ 1.9
Watering	Will (act) ± int. (calc)	3	+ 13.2	+ 7.7	+ 32.6	−1.73	−0.91	− 1.23	− 0.90	+ 5.0	−0.6	−0.4	+ 11.6	+ 4.5	− 1.5
	Int. (act) ± will (calc)	4	− 26.1	− 18.0	− 53.6	+3.19	+1.42	+ 3.93	+ 1.91	− 8.6	+1.3	+0.6	+ 8.5	+ 7.1	+ 3.1
Grooming	Gr. (act) ± no gr. (calc.	3	+ 5.8	− 4.5	− 9.1	+1.94	+0.82	+ 4.99	+ 2.26	− 3.6	+1.0	+0.5	+ 1.9	+ 5.2	+ 2.2
	No gr. (act) + gr. (calc)	2	+ 20.6	− 0.4	+ 5.4	+0.72	+0.38	+ 3.47	+ 1.67	− 3.5	+0.1	+0.1	+ 4.7	+ 2.7	+ 1.3
Exp. error.	Exp. error; IV	3	− 13.4	+ 3.1	− 12.8	+0.46	+0.22	− 0.19	+ 0.10	− 0.5	+0.3	+0.2	− 11.4	− 0.7	− 0.2
	Exp. error; B. G.	2	− 7.1	+ 2.7	+ 30.5	+0.98	+0.47	+ 0.92	− 0.08	+ 4.0	+0.2	+0.1	+ 8.0	− 0.1	− 0.2
	Exp. error; II	4	− 54.3	+ 3.9	+ 13.4	−0.89	−0.49	− 0.07	− 0.20	+ 1.8	+0.2	0.0	+ 1.0	− 0.2	− 0.1

(*b*) PERCENTAGE DIFFERENCES

Nature of experiment	FEEDS	Periods represented	Total dry matter eaten	Dry matter eaten in experimental fodder	Milk	Total solids	Fat	Total solids	Fat	WEIGHT OF PRODUCTS OBTAINED PER 100 LBS. OF DRY MATTER: IN ENTIRE RATION — Milk	Total solids	Fat	IN EXPERIMENTAL FODDER — Milk	Total solids	Fat
			lbs	lbs	lbs	%	%	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs
Equal balance	B. G. (act) ± II (calc)	11	+ 1	+ 13	+ 5	0	− 2	+ 5	+ 4	+ 4	+ 4	+ 3	− 9	− 9	− 10
	II (act) ± B. G. (calc)	12	− 2	− 15	− 8	+ 1	+ 2	− 7	− 5	− 6	− 5	− 4	+ 6	+ 7	+ 8
Equal balance	O. F. (act) ± IV (calc)	3	+ 3	+ 3	+ 1	− 1	+ 1	− 1	0	− 2	− 4	− 3	− 2	− 4	− 3
	IV (act) ± O. F. (calc)	3	− 1	− 1	− 2	0	0	0	0	+ 4	+ 1	+ 1	+ 2	+ 2	+ 1
Unemul. C. S. oil (1898)	Oil (act) ± bran (calc)	2	+ 1	.....	+ 5	2 +	7 +	7 +	13 +	3 +	5 +	10	.....	.....	.....
Emul. C. S. oil (1898)	Oil (act) ± bran (calc)	2	+ 2	.....	+ 8	0	+ 3	+ 6	+ 10	+ 4	+ 2	+ 5′	.....	.....	.....
Emul. C. S. oil	IV (act) ± C.S.oil (calc)	3	0	.....	− 6	0	− 4	− 5	− 9	− 7	− 7	− 11	.....	.....	.....
	C.S.oil (act) ± IV (calc)	4	+ 3	.....	+ 6	0	+ 5	+ 6	+ 12	+ 10	+ 10	+ 17	.....	.....	.....
Emul. Co. oil	IV (act) ± Corn oil (cal)	3	+ 5	.....	− 1	+ 6	+ 9	+ 4	+ 6	− 3	− 2	+ 1	.....	.....	.....
	Corn oil (act) ± IV (calc)	4	− 2	.....	+ 3	− 5	− 7	− 2	− 2	+ 1	0	− 1	.....	.....	.....
Emul. L. oil	IV (act) ± Lin. oil (calc)	3	0	.....	+ 1	+ 1	− 1	+ 3	0	0	0	− 2	.....	.....	.....
	Lin oil (act) ± IV (calc)	4	− 5′	.....	0	− 3	− 4	− 3	+ 4	+ 7	+ 3	+ 2	.....	.....	.....
Med. & wide	O. F. (act) ± I (calc)	4	+ 1	+ 21	− 5	− 1	− 2	− 6	− 6	− 6	− 6	− 7	− 9	− 9	− 10
	I (act) ± O. F. (calc)	2	0	− 1	+ 6	+ 1	+ 1	+ 7	+ 7	+ 6	+ 7	+ 7	+ 7	+ 8	+ 8
Med. & scant.	B. G. (act) ± V (calc)	6	+ 13	.....	+ 17	− 2	− 6	+ 16	+ 14	+ 3	+ 4	0	.....	.....	.....
	V (act) ± B. G. (calc)	6	− 16	.....	− 26	+ 4	+ 8	− 22	− 18	− 8	− 5	− 1	.....	.....	.....

Nature of experiment	FEEDS	Periods represented	Total dry matter eaten	Dry matter eaten in experimental fodder	Milk	Total solids	Fat	Total solids	Fat	WEIGHT OF PRODUCTS OBTAINED PER 100 LBS. OF DRY MATTER — IN ENTIRE RATION: Milk	Total solids	Fat	IN EXPERIMENTAL FODDER: Milk	Total solids	Fat
			lbs	lbs	lbs	%	%	lbs	lbs	lbs.	lbs	lbs	lbs	lbs	lbs	lbs
Buckwheat mid	III (act) ± I (calc)	3	0 + 3	3 − 3	1 − 2	2 − 3	2 − 3			3 − 3	2 − 2		7 − 6		5
	I (act) ± III (calc)	1 − 5	− 15	− 6	+ 4	+ 5	+ 2	− 1		− 1	+ 3	+ 4	+ 8	+ 11	+ 12
B'kw't mid	III (act) ± II (calc)	1 + 6	+ 15	+ 5	+ 2	+ 4	+ 7	+ 10	− 1	0	+ 3	− 11	− 9	− 6	
	II (act) ± III (calc)	1 − 7	− 14	0	+ 2	− 1	+ 3	0	+ 2	+ 9	+ 6	+ 12	+ 14	+ 12	
B'kw't mid	III (act) ± IV (calc)	2 − 2	0	+ 1	0	0	+ 1	+ 2	+ 2	+ 2	+ 3	0	0	+ 1	
	IV (act) ± III (calc)	1 + 1	0	− 4	− 1	0	− 5	− 4	− 5	− 6	− 5	− 4	− 4	− 3	
Buckwheat mid	B. M. (act) ± IV (calc)	1 + 3	− 4	+ 4	+ 1	+ 8	+ 5	+ 12	0	+ 1	+ 8	+ 8	+ 8	+ 15	
Watering	Will (act) Int. (calc)	3 + 1	+ 2	+ 3	− 4	− 6	− 1	− 2	+ 2	− 2	− 3	------	------	------	
	Int. (act) ± Will (calc)	4 − 2	− 3	− 4	+ 5	+ 7	+ 2	+ 3	− 3	+ 3	+ 3	------	------	------	
Grooming	Gr (act) ± not gr (cal)	3	0 − 1	− 1	+ 4	+ 5	+ 3	+ 4	− 1	− 3	− 3	------	------	------	
	Not gr. (act) ± gr (calc)	2 + 2	0	+ 1	+ 2	+ 4	+ 3	+ 4	− 2	0	+ 2	------	------	------	
Exper'tal error	Experimental error IV	3 + 1	+ 1	− 1	+ 1	+ 1	0	0	0	+ 1	+ 3	− 2	− 1	0	
	" " B G	2 − 1	+ 1	+ 4	− 3	− 4	+ 1	0	+ 5	+ 1	+ 2	+ 3	− 2	− 1	
	" " II	4 − 2	+ 1	− 1	− 1	− 2	0	0	+ 4	+ 2	+ 3	+ 1	− 1	− 1	

VII. RESULTS OF EXPERIMENTAL FEEDING ON DIFFERENT RATIONS

FEEDS	Total dry matter eaten	Dry matter eaten in experimental fodder	Milk	Total solids	Fat	Total solids	Fat	WEIGHT OF PRODUCTS OBTAINED PER 100 LBS. OF DRY MATTER: IN ENTIRE RATION: Milk	IN ENTIRE RATION: Total solids	IN ENTIRE RATION: Fat	IN EXPERIMENTAL FODDER: Milk	IN EXPERIMENTAL FODDER: Total solids	IN EXPERIMENTAL FODDER: Fat	Ratio of per cent of fat to per cent of solids-not-fat
EQUAL BALANCE—BUFFALO GLUTEN FEED VS. MIXED FEED NO. 2. 529 DAYS' FEEDING ON EACH RATION														
	lbs	lbs	lbs	%	%	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	1 :
B G	13899	3877	12491	14.23	4.95	1729.22	588.39	89.1	12.4	4.3	321.8	44.6	15.2	1.87
II	13692	3376	11699	14.33	5.04	1627.54	560.11	84.7	11.9	4.2	346.7	48.2	16.6	1.84
II ± B G	−207	−501	−792	+0.10	+ 0.09	−101.68	−28.28	− 4.4	−0.5	- 0.1	+24.9	+ 3.6	+ 1.4	−0.03
Percentage differences	−1	−13	−6	+1	+ 2	−6	−5	−5	−4	−2	+8	+8	+9	−2
EQUAL BALANCE—OAT FEED VS. MIXED FEED NO. 4. 118 DAYS' FEEDING ON EACH RATION														
O F	2707	783	2091	14.83	5.54	301.33	109.58	77.9	11.2	4.1	266.9	38.5	14.0	1.68
IV	2660	767	2094	14.91	5.52	303.47	109.38	79.7	11.5	4.1	272.7	39.5	14.3	1.70
IV ± O F	− 47	− 16	+ 3	+0.08	−0.02	+2.14	−0.20	+1.8	+0.3	0	+5.8	+1.0	+0.3	+0.02
Percentage differences	−2	−2	0	+1	0	+1	0	+2	+3	0	+2	+3	+2	+1
COTTONSEED OIL FEEDING (UNEMULSIFIED) (1898). 46 DAYS' FEEDING														
Bran	1098	....	1170	13.07	4.42	151.66	50.82	106.6	13.9	4.7	.....	.....	.....	1.96
Oil & bran	1117	....	1232	13.30	4.75	162.21	57.46	110.0	14.6	5.2	.....	.....	.....	1.80
Oil & bran ± bran	+19	....	+62	+0.23	+0.33	+10.55	+6.64	+3.4	+0.7	+0.5	.....	.....	.....	−0.16
Percentage differences	+1	....	+5	+2	+7	+7	+13	+3	+5	+10	.....	.....	.....	−8
COTTONSEED OIL FEEDING (EMULSIFIED) (1898). 46 DAYS' FEEDING														
Bran	1209	....	1019	13.76	4.70	139.29	46.64	86.6	11.9	4.0	.....	.....	.....	1.93
Oil & bran	1233	....	1099	13.70	4.82	148.05	51.32	89.8	12.1	4.2	.....	.....	.....	1.84
Oil & bran ± bran	+24	....	+80	−0.06	+0.12	+8.76	+4.68	+3.2	+0.2	+0 2	.....	.....	.....	−0.09
Percentage differences	+2	....	+8	0	+3	+6	+10	+4	+2	+5	.....	.....	.....	−5

FEEDS	Total dry matter	Dry matter eaten in experimental fodder	WEIGHT OF PRODUCTS OBTAINED PER 100 POUNDS OF DRY MATTER: IN ENTIRE RATION: Milk	IN ENTIRE RATION: Total solids	IN ENTIRE RATION: Fat	IN EXPERIMENTAL FODDER: Total solids	IN EXPERIMENTAL FODDER: Fat	IN ENTIRE RATION: Milk	IN ENTIRE RATION: Total solids	IN ENTIRE RATION: Fat	IN EXPERIMENTAL FODDER: Milk	IN EXPERIMENTAL FODDER: Total solids	IN EXPERIMENTAL FODDER: Fat	Ratio of per cent of fat to per cent of solids-not-fat
COTTONSEED OIL FEEDING (EMULSIFIED). 126 DAYS' FEEDING ON EACH RATION														
	lbs	lbs	lbs	%	%	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	1 :
IV	2849	....	2480	14.28	4.85	350.45	117.52	85.4	12.1	4.1	.....	.....	.....	1.94
IV & C. S. O.	2794	....	2625	14.22	5.07	369.83	130.08	93.4	13.2	4.7	.....	.....	.....	1.80
Oil ± IV	−55	....	+145	−0.06	+0.22	+19.38	+12.56	+8.0	+1.1	+0.6	.....	.....	.....	−0.14
Percentage differences	−2	....	+6	0	+5	+5	+11	+9	+9	+15	.....	.....	.....	−7
CORN OIL FEEDING (EMULSIFIED). 126 DAYS' FEEDING ON EACH RATION														
IV	3162	....	2158	15.09	5.41	321.27	113.01	67.6	10.1	3.6	.....	.....	.....	1.79
IV & C. S. O.	3058	....	2204	14.26	5.00	312.78	108.70	71.8	10.3	3.6	.....	.....	.....	1.85
Oil ± IV	−104	....	+46	−0.83	−0.41	−8.49	−4.31	+4.2	+0.2	0	.....	.....	.....	+0.06
Percentage differences	−3	....	+2	−6	−8	−3	−4	+6	+2	0	.....	.....	.....	+3
LINSEED OIL FEEDING (EMULSIFIED). 126 DAYS' FEEDING ON EACH RATION														
IV	3312	....	1882	14.35	5.04	270.09	94.76	57.0	8.2	2.9	.....	.....	.....	1.85
IV & L. oil	3203	....	1875	14.00	4.95	262.24	92.28	59.2	8.3	2.9	.....	.....	.....	1.83
Oil ± IV	−109	....	−7	−0.35	−0.09	−7.85	−2.48	+2.2	+0.1	0	.....	.....	.....	−0.02
Percentage differences	−3	....	0	−2	−2	−3	−3	+4	+1	0	.....	.....	.....	−1
OAT FEED VS. MIXED FEED NO. 1. 118 DAYS' FEEDING ON EACH RATION														
O F	2989	871	2296	14.62	5.42	330.50	121.19	77 5	11.1	4.1	267.9	38.2	13.9	1.70
1	2974	848	2423	14.83	5.52	351.01	128.78	82.2	11.9	4.4	290.6	41.8	15.2	1.69
I ± O F	−15	−23	+127	+0.21	+0.10	+20.51	+7.59	+4.7	+0.8	+0.3	+22.7	+3.6	+1.3	−0.01
Percentage differences	−1	−3	+5	+1	+2	+6	+6	+6	+7	+7	+8	+9	+9	0

FEEDS	Total dry matter eaten	Dry matter eaten in experimental fodder	Milk	Total solids	Fat	Total solids	Fat	WEIGHT OF PRODUCTS OBTAINED PER 100 LBS. OF DRY MATTER: IN ENTIRE RATION: Milk	IN ENTIRE RATION: Total solids	IN ENTIRE RATION: Fat	IN EXPERIMENTAL FODDER: Milk	IN EXPERIMENTAL FODDER: Total solids	IN EXPERIMENTAL FODDER: Fat	Ratio of per cent of fat to per cent of solids-not-fat
	lbs	lbs	lbs	%	%	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	1 :
BUFFALO GLUTEN MEAL VS. MIXED FEED NO. 5. 276 DAYS' FEEDING ON EACH RATION														
V	6139	756	3604	15 60	5.92	554.46	207.55	58.6	9.0	3.4	-----	-----	-----	1.64
B G	7109	1950	4435	15.13	5.52	668.34	242.30	61.9	9.3	3.4	-----	-----	-----	1.74
B G ± V	+970	+1194	+831	−0.47	−0.40	+113.88	+34.75	+3.3	+0.3	0	-----	-----	-----	+0.10
Percentage differences	+16	0	+23	−3	−7	+21	+17	+6	+3	0	-----	-----	-----	+6
MIXED FEED NO. 3 VS. MIXED FEED NO 1. 82 DAYS' FEEDING ON EACH RATION														
III	2002	589	1920	13.44	4.50	256.38	85.32	95.6	12.8	4.3	325.6	43.8	14.6	1.99
I	1977	556	1931	13.48	4.49	259.70	86.19	97.8	13.2	4.4	348.5	47.0	15.6	2.00
I ± III	−25	−33	+11	+0.04	−0.01	+3.32	+0.87	+2.2	+0.4	+0.1	+22.9	+3.2	+1.0	+0.01
Percentage differences	−1	−6	+1	0	0	+1	+1	+2	+3	+2	+7	+7	+7	+1
MIXED FEED NO. 3 VS. MIXED FEED NO. 2. 46 DAYS' FEEDING ON EACH RATION														
III	873	325	524	14.97	5.51	78.51	28.85	60.1	9.0	3.3	161.7	24.2	8.9	1 72
II	817	282	511	15.01	5.37	76.70	27.44	62.7	9.4	3.4	181.7	27.3	9.8	1.80
II ± III	−56	−43	−13	+0.04	−0.14	−1.81	−1.41	+2.6	+0.4	+0.1	+20.0	+3.1	+0.9	+0.08
Percentage differences	−7	−13	−2	0	−3	−2	−5	+4	+4	+3	+12	+13	+10	+5
MIXED FEED NO. 3 VS. MIXED FEED NO. 4. 54 DAYS' FEEDING IN EACH RATION														
III	1372	391	1478	13.54	4.47	200.07	65.91	107.8	14.6	4 8	378.2	51.2	16.9	2.03
IV	1392	389	1452	13.53	4.46	196.25	64.41	104.4	14.1	4.6	373.0	50.4	16.6	2.03
IV ± III	+20	−2	−26	−0.01	+0.01	−3.82	−1.50	−3.4	−0.5	−0.2	−5.2	−0.8	−0.3	0
Percentage differences	+1	−2	−2	0	0	−2	−2	−3	−4	−4	−1	−2	−2	0

FEEDS	Total dry matter eaten	Dry matter eaten in experimental fodder	WEIGHTS OF PRODUCTS OBTAINED PER 100 POUNDS OF DRY MATTER. IN ENTIRE RATION: Milk	Total solids	Fat	IN EXPERIMENTAL FODDER: Total solids	Fat	Milk	Total solids	Fat	Ratio of per cent of fat to per cent of solids-not-fat
BUCKWHEAT MIDDLINGS VS. MIXED FEED NO. 4. 18 DAYS' FEEDING ON EACH RATION											
	lbs	lbs	lbs	%	%	lbs	lbs	lbs	lbs	lbs	lbs	lbs	1 :
B M	423	125	319	14.08	4.97	44.89	15.85	75.4	10.6	3.8	254.8	35.9	12.7	1.83
IV	410	130	307	13.88	4.55	42.71	14.00	75.2	10.5	3.4	237.0	32.9	10.8	2.05
IV ± B M	−13	+5	−12	−0.20	−0.42	−2.18	−1.85	−0.2	−0.1	−0.4	−17.8	−3.0	−1.9	+0.22
Percentage differences	−3	+4	−4	−1	−8	−5	−12	−3	−1	−11	−7	−8	−15	+12
ARTICHOKES VS. SILAGE. 18 DAYS' FEEDING ON EACH RATION														
Artichokes	392	....	346	15.71	5.75	54.38	19.90	88.3	13.9	5.1	.....	.....	.....	1.73
Silage	423	....	333	15.61	5.87	51.86	19.50	78.6	12.3	4.7	.....	.....	.....	1.66
Si. ± art.	+31	....	−13	−0.10	+0.12	−2.52	−0.40	−9.7	−1.6	−0.4	.....	.....	.....	−0.07
Percentage differences	+8	....	−4	−1	+2	−5	−2	−11	−12	−8	.....	.....	.....	−4
WATER AT WILL OR AT INTERVALS. 126 DAYS' FEEDING EACH WAY														
Will	2919	889	2541	14.34	5.12	358.23	126.54	84.1	12.0	4.2	.....	.....	.....	1.80
Intervals	2879	863	2455	15.04	5.45	363.39	129.35	82.2	12.2	4.4	.....	.....	.....	1.76
Int. ± will	−40	−26	−86	+0.70	+0.33	+5.16	+2.81	−1.9	+0.2	+0.2	.....	.....	.....	−0.04
Percentage differences	−1	−3	−3	+5	+6	+1	+2	−2	+1	+5	.....	.....	.....	−2
GROOMING OR NO GROOMING. 90 DAYS' FEEDING EACH WAY														
Grooming	2073	649	1740	15.24	5.63	262.15	96.14	83.0	12.5	4.6	.....	.....	.....	1.70
No grooming	2088	653	1754	15.00	5.54	260.63	95.55	83.0	12.3	4.5	.....	.....	.....	1.71
No gr. ± gr.	+15	+4	+14	−0.24	−0.09	−1.52	−0.59	0	−0.2	−0.1	.....	.....	.....	+0.01
Percentage differences	+1	+1	+1	−2	−2	−1	−1	0	−2	−2	.....	.....	.....	+1

FEEDS	Total dry matter eaten	Dry matter eaten in experimental fodder	Milk	Total solids	Fat	Total solids	Fat	WEIGHT OF PRODUCTS OBTAINED PER 100 LBS. OF DRY MATTER: IN ENTIRE RATION: Milk	IN ENTIRE RATION: Total solids	IN ENTIRE RATION: Fat	IN EXPERIMENTAL FODDER: Milk	IN EXPERIMENTAL FODDER: Total solids	IN EXPERIMENTAL FODDER: Fat	Ratio of per cent of fat to per cent of solids-not-fat
	lbs	lbs	lbs	%	%	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	1 :
EXPERIMENTAL ERROR. 69 DAYS' FEEDING														
IV	1458	496	962	15.35	5.75	148.95	56.13	65.5	10.1	3.8	194.2	30.1	11.3	1.67
IV	1445	499	949	15.51	5.83	148.76	56.23	65.3	10.2	3.9	190.4	29.9	11.3	1.66
IV ± IV	+13	+3	−13	+0.16	+0.08	−0.19	+0.10	−0.2	+0.1	+0.1	−3.8	−0.2	0	−0.01
Percentage differences	+1	+1	−1	+1	+1	0	0	0	+1	+3	−2	−1	0	1—
EXPERIMENTAL ERROR. 46 DAYS' FEEDING														
B G	920	292	797	15.52	5.70	123.42	45.26	86.7	13.4	4.9	272.8	42.2	15.5	1.72
B G	913	295	827	15.03	5.47	124.34	45.18	90.7	13.6	5.0	280.8	42.2	15.3	1.75
B G ± B G	−7	+3	+30	−0.49	−0.23	+0.92	−0.08	+4.0	+0.2	+0.1	+8.0	−0.1	−0.2	+0.03
Percentage differences	−1	+1	+4	−3	−4	+1	0	+5	+1	+2	+3	−2	−1	+2
EXPERIMENTAL ERROR. 92 DAYS' FEEDING														
II	2289	586	1113	16.69	6.68	185.39	73.81	48.6	8.1	3.2	190 1	31.7	12.6	1.49
II	2235	589	1126	16.47	6.55	185.32	73.61	50.4	8.3	3.3	191.1	31.5	12.5	1.51
II ± II	−54	+3	+13	−0.22	−0.13	−0.07	−0.20	+1.8	+0.2	+0.1	+1.0	−0.2	−0.1	+0.02
Percentage differences	−2	+1	+1	−1	−2	0	0	+4	+2	+3	+1	−1	−1	+1

NOTE EXPLANATORY OF VI "DIFFERENCE TABLES," (PAGES 340-343) AND VII "RESULTS OF EXPERIMENTAL FEEDING," (PAGES 344-348)

Although "difference tables" have been printed in the last three reports accompanied by full explanations of their meaning, they are so condensed from the data of table V that explanatory notes seem still in order.

When a cow eats a certain ration during a feeding period, another during a second period, returning to the first ration for a third period, all three being of equal lengths, and, as far as may be, all other things being equal, it is fair to assume, and in the discussion of feeding experiments is usually assumed, that the average of the results obtained during the first and third periods on the ration then fed is what would have been secured during the second period had the feeding continued on one ration. A comparison of this average with the results actually obtained with another ration serves to show the relative value of the different fodders and feeds. The *difference between these calculated averages and the actual results* form the "differences" which measure the relative values of the two rations.

The first comparison of the record of the cow Sue is given in full to show more clearly just what is meant by the figures in the "difference tables."

Record of SUE for the experimental portions of periods I, III and II. (See page 330)	Total dry matter eaten	Dry matter eaten in experimental fodder	Milk	Total solids	Fat	Total solids	Fat	Weight of products obtained per 100 lbs of dry matter: In entire ration: Milk	In entire ration: Total solids	In entire ration: Fat	In experimental fodder: Milk	In experimental fodder: Total solids	In experimental fodder: Fat
	lbs	lbs	lbs	%	%	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs
Average of actual records for period I and III (Mixed feed No 2)	600.8	146.7	468.4	13.55	4.29	63.44	20.08	78.0	10.6	3.4	319.4	43.5	13.7
Actual record for period 2. (Buffalo gluten feed)	591.4	168.9	518.3	13.28	4.03	68.84	20.87	87.7	11.6	3.5	306.9	40.8	12.4
Record made upon Buffalo gluten feed ± the average of those made on mixed feed No. 2	−9.4	+22.2	+49.9	−0.27	−0.26	+5.40	+0.79	+9.7	+1.0	+0.1	−12.5	−2.7	−1.3

The first horizontal line of figures shows the average of the records of dry matter eaten, of milk, solids, and fat given, etc., obtained during the experimental portions of the first and third feeding periods, while the cow was eating the cottonseed-linseed (mixed feed No. 2) ration, (page 330). The second horizontal line of figures shows the actual records of dry matter, milk, etc., obtained during the experimental portion of the second period, while the cow was eating the Buffalo gluten feed ration, (second line page 330). The third horizontal line shows the amounts, greater or less as the case may be, of dry matter eaten, milk given, etc., when the Buffalo gluten feed ration was fed as compared with the average of the records on the cottonseed-linseed (mixed feed No. 2) ration. These differences furnish a measure of the relative value of the two rations, it being assumed, as stated above, that the averages correctly indicate the consumption and production which would have occurred during the intervening period had the ration remained unchanged.

The figures in the third horizontal line in the above table, together with ten other sets similarly obtained by comparing Sue's average of periods III and V with IV, Haidee's II and IV with III, and IV and VI with V, Atalanta's III and V with IV, Nancy B's II and IV with III, and IV and VI with V, Goldie's I and III with II, and III and V with IV, Eva's II and IV with III, and Acme's III and V with IV, added, each column by itself, give the first horizontal line in table (*a*) "totals of differences," beginning 11, +90.2, +247.8, etc. The figures in table (*b*) "percentage differences," which are the final results and measures of the relative worth of the various rations, are obtained by dividing the "total differences" by the total actual consumption (of dry matter) or production (of milk, solids, fat and the same proportionate to 100 pounds of dry matter eaten). Thus for example, the calculated amounts of dry matter eaten when the mixed feed No. 2 was fed to the cows, Sue, Haidee, Atalanta, Nancy B., Goldie, Eva and Acme in the averages of the experimental portions of the periods mentioned in couplets—for example, Sue I and III, Haidee II and IV—was 6639.1 pounds. This is 90.2 pounds less than the amounts actually eaten when the Buffalo ration was fed; $90.2 \div 6639.1 \times 100 = 1.36$. Hence we say that the "percentage difference" is +1, or, in other words, that the cows fed on the mixed feed ration ate 1 per cent more dry matter than would have been the case had they eaten the Buffalo ration at precisely the same time they did eat the mixed feed. This figure (+1) leads the first horizontal line in table (*b*) "percentage differences." Similar comparisons with the remaining items show the per cent of excess of consumption or product resulting from the use of mixed feed No. 2 as compared with Buffalo gluten feed.

The outcome of the experiments is also shown in a somewhat different manner in table VII "Results of Experimental Feeding on Different Rations," wherein the total products for each period and for each calculated period are added. Thus for example, in the care of the seven cows named above, fed 23 five-week periods, including 23 twenty-three-day experimental portions, a comparison of 529 days feeding for one cow on each ration may be made and neither side of the comparison suffer from the effects of advancing lactation, this being equalized. The use of the data found in table V "Production Records," with the cows in question for the experimental portion of the periods stated below will give the equivalent of 529 days feeding on the Buffalo ration.

Sue, periods II and IV; Goldie. II and IV	92	days feeding
Haidee, periods III and V; Nancy B., III and V	92	" "
Atalanta, period IV; Eva, period III; Acme, period IV	69	" "
Sue, Atalanta and Goldie; each the average of records of periods II and IV and of IV and VI on the Buffalo ration; equivalent respectively to what might reasonably have been expected to have been the results in periods III and V had the feeding on Buffalo gluten been continued	138	" "
Acme; the average of records of periods IV and VI on the Buffalo ration; equivalent, etc. to period V on Buffalo gluten feed	23	" "
Haidee and Eva; each the average of records of periods I and III, and of III and V on the Buffalo ration; equivalent, etc. to period II and IV on the Buffalo gluten feed	92	" "
Nancy B.; the average of records of periods III and V on the Buffalo ration; equivalent, etc. to period IV on Buffalo gluten feed	23	" "
Equivalent to 529 days feeding		

Using the data on the mixed feed ration the following combination gives 529 days feeding on the cottonseed-linseed (mixed feed No. 2 ration :)

Haidee, periods II and IV; Eva, II and IV	92	days feeding
Sue, periods III and V; Alatanta, III and V; Goldie, III and V	138	" "
Nancy B., period IV; Acme, period V	46	" "
Haidee and Nancy B.; each the average of records of periods II and IV, and of IV and VI on the mixed feed ration; equivalent, etc. to period III and V on mixed feed	92	" "
Eva; the average of records of periods II and IV on the mixed feed ration; equivalent, etc. to period III on the mixed feed	23	" "
Sue and Goldie; each the average of records of periods I and III and of III and V on the mixed feed ration; equivalent, etc. to periods II and IV on mixed feed	92	" "
Atalanta and Acme; each the average of record of periods III and V on the mixed feed ration; equivalent, etc. to period IV on mixed feed	46	" "
	Equivalent to 529	days feeding

This permits the calculation of the consumption and production of each cow on each ration for the selfsame days of the experimental portion of the periods other than the first and last used with each cow, thus affording an excellent and accurate measure of the relative worth of the two rations. The result of this comparison is given in table VII (page 344) in the first set, the Buffalo figures beginning 13899, 3877, 12491, and the mixed feed data 13691, 3376, 11699. The average percentages of total solids and fat are obtained by addition and not by cross division. This gives to each cow the same influence upon the final results, instead of giving greatest preponderance to those yielding most largely of milk, solids and fat, and less to those giving smaller amounts.

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